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THE GEOGRAPHICAL REVIEW

PUBLISHED BY

THE AMERICAN GEOGRAPHICAL SOCIETY
OF NEW YORK

JUNE

1917

THE GEOGRAPHICAL REVIEW

Published monthly by the American Geographical Society

Broadway at 156th Street, New York, N. Y.

June, 1917

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Single numbers, fifty cents — Five dollars a year

Entered as second-class matter, January 22, 1916, at the Post Office at New York, N. Y., under the act of August 24, 1912

Press of Douglas Taylor & Co., New York

THE
GEOGRAPHICAL REVIEW

VOL. III JUNE, 1917 NO. 6

THE CARPATHIANS: PHYSIOGRAPHIC FEATURES CONTROLLING HUMAN GEOGRAPHY*

By EMMANUEL DE MARTONNE
Professor of Geography at the University of Paris

[With separate map, Pl. IV, facing p. 432.]

Though the Carpathians are one of the great mountain chains of Europe they are not so widely known as the Alps. They have no glaciers and no high mountain scenery to attract the tourist. History has rarely been gravely affected by them, and only the great European war has revealed their strategical importance. Very few physiographers have carried on elaborate field studies in the Carpathians. We even have no accurate topographical maps of portions of the Southern Carpathians, and the writer in studying this region was obliged first to survey extensive areas and in doing this discovered twenty unnamed lakes in the Paringu massif. Nevertheless the Carpathians, no less than the Alps, teach some wonderfully clear lessons in physical and human geography.

The length of the Carpathians, measured from Pressburg to the Iron Gates, is nearly equal to the length of the Alps, and the area is likewise the same. But the mean height is much lower, and the maximum height is a little more than half (Tatra, 2,663 meters, or 8,737 feet; Mont Blanc, 4,810 meters, or 15,781 feet). The Carpathians are ordinarily believed to be a true "alpine chain," that is to say, one of those young folded mountains which extend across Europe and Asia from the Pyrenees to the Himalayas. Their outline is that of a bow, with a more definitely marked outer front; but the map (Pl. IV) shows that the bow is nearly broken in the middle. The width of the chain is reduced at this point from 300 to less than 100 kilometers (180 to 60 miles); its mean height falls below

* The following comment on the spelling of place-names in the article and on the map may be serviceable. Hungarian and Rumanian names are given in their native form, diacritical marks being omitted, however; and no phonetic transliteration has been attempted except in the case of the Rumanian *ţ*, which has been rendered *ts*. In addition it should be borne in mind that Hungarian *s* and Rumanian *ş* are pronounced *sh*, e.g. Fogaras, *Fogarash*; Piteşti, *Pitéshti*; Arges, *Argesh*, etc.

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FIG. 1.

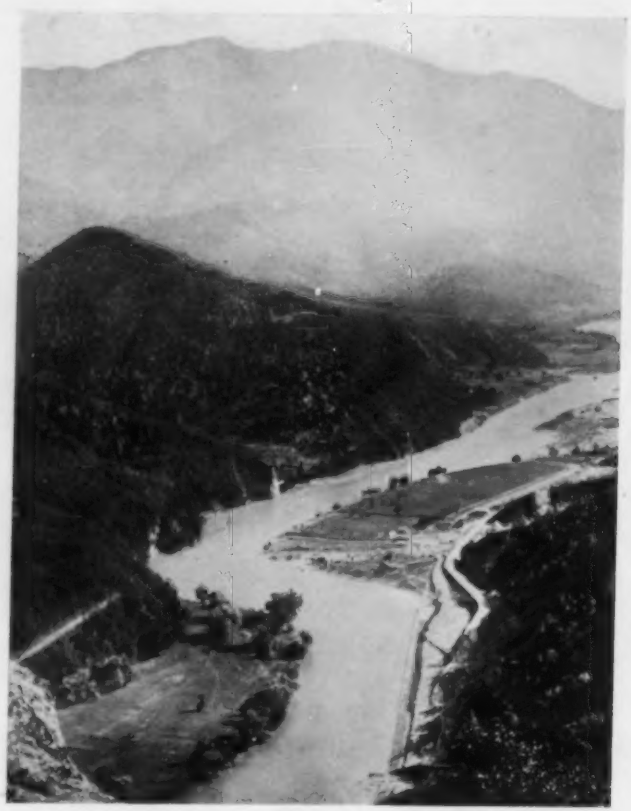


FIG. 2.

FIG. 1—The Surduc gorge: transverse valley of the Jiu River across the Transylvanian Alps between Petroseny and Targu Jiu.

FIG. 2—Transverse valley region of the Olt River: looking down to the main valley of Titesti. Maturely dissected flysch basin; wide, open valley with terraces and alluvial flats.

1,000 meters (3,300 feet), and a group of very low passes connects the headwaters of the Dniester with those of the Tisza.

This peculiar feature is one of greatest importance because it controls in a fundamental way the biogeography, economic life, and military strategy of the area. We know from the studies of Pax[1] that important types of vegetation extend bandlike through the Dukla Pass. Three railroads cross the Carpathians in this region, viz., by the Lupkov Pass, the Uzsok Pass, and the Verecze Pass. It is by these easy passes that the Magyars, coming from the plains of southern Russia, made their way to the plain of the middle Danube, which they have occupied since the eighth century. In the present war, this is the only place at which the Russians have yet succeeded in crossing the Carpathians and menacing the capital of the Austro-Hungarian Empire.

That a young folded mountain range is so shrunk in the middle of its bow can be explained only by downwarping and breaking. As a matter of fact, the great Hungarian plain, which here extends northward into the very heart of the Carpathians, has been proved to be an area of continuous subsidence, its Neocene beds extending 1,000 meters (3,300 feet) below sea level. The upper Tisza flows at an altitude of only 100 meters even at the foot of the mountains. All the geological horizons exhibited in the Carpathians are missing here, and what remains of the range is only the outer belt of flysch* sandstones. Volcanic massifs show by their structure and distribution that fracturing accompanied downwarping.

Through this shrinking the Carpathians were divided into two masses, now entirely different as to orographic and geologic structure and no less different regarding their biogeography and human geography.

The Northern Carpathians, although bearing the highest peaks of the whole chain (Tatra, 2,663 meters, or 8,737 feet), have not so great a mean height as the Southern Carpathians. They appear as a complex of isolated massifs, broad and low depressions and basins—an extremely shattered range; while in the Southern Carpathians the most striking feature is the great basin of Transylvania, surrounded on all sides by high massifs. The geological structure of the Northern Carpathians is very complicated, and in this respect it is hard to find any relation between the Northern and the Southern Carpathians. The only formation which extends from one to the other is the outer belt of folded flysch sandstones, and even these do not continue into the Transylvanian Alps.

Because of the location of this part of the range the climate and the plant life of the Northern Carpathians are like those of the bordering plains of Poland. In the Beskids a dense forest of firs and beeches extends down to

[1] F. Pax: Grundzüge der Pflanzenverbreitung in den Karpathen, Vol. 1 (*Die Vegetation der Erde*, edit. by Engler and Drude, Vol. 2). Engelmann, Leipzig, 1898.

* Flysch is the name, of Swiss origin, given to the complex of marly and sandy shales and soft sandstones, probably of Eocene or Oligocene age, which accompany the outer, convex border of the Alps and the Carpathians.—EDIT. NOTE.

the very foot of the mountains. The timber line is remarkably low, the alpine zone commencing at 1,400 meters (4,600 feet) in the Tatra. The vine is not grown; few fruit trees are seen, except in the southernmost massifs bordering the great Hungarian plain. The climate of the Southern Carpathians is continental to a high degree, and the winters are as severe in the Transylvanian Basin as in the valleys of the Beskids, but the summers are warmer. The vine is grown everywhere, and corn is cultivated up to 800 meters (2,600 feet). The timber line is found at 1,800 meters (5,900 feet). The alpine flora is richer. The subalpine forest zone, with fir and beech, does not extend down to the lowlands; it is the oak forest which covers the basal slopes.

Even in ethnographical conditions and economic life there are striking contrasts between the Northern and the Southern Carpathians. The former are inhabited mainly by North Slavs, while the Magyars penetrate the valleys which open widely southward to the great Hungarian plain, and their distribution coincides precisely with the dry climate, the oak forest, the vineyards, and the loess soil which is so well fitted for wheat culture. The Southern Carpathians are the domain of the Rumanians. Magyars appear only in the Transylvanian Basin, while the Ruthenians occupy the northern corner in Bukovina and eastern Galicia. The upper limit of the permanently inhabited region is everywhere much lower than in the Alps, but it seems to be particularly low in the Northern Carpathians, where, with the exception of some mining towns, we find that even villages do not occur higher than 700 meters (2,300 feet). By contrast, in the Southern Carpathians fields and small villages may occasionally be seen as high as 1,000 meters (3,300 feet). Pastoral life is much more developed, and in the summer large flocks of sheep graze over the flat-topped ridges above the timber line.

The Northern Carpathians are not easily accessible from any important commercial highway. The railways avoid crossing them, as, for example, the main line from Vienna to Cracow and Lemberg. The Southern Carpathians cannot be avoided by the commerce directed to the Orient and are crossed by two trunk railways with express service, namely, at the Iron Gates and at Predeal Pass, and by three railways of less importance, mainly by way of the transverse valley of the Olt (Red Tower Pass), the pass between the upper Olt and the Sereth (Gyimes Pass), and the pass between the headwaters of the Tisza and the Pruth (Jablonica Pass).

The Transylvanian Alps

It is in the Southern Carpathians that the most intensive physiographic studies have been carried on.[2]

The Transylvanian Alps form the southernmost part of the Carpathians

[2] E. de Martonne: Recherches sur l'évolution morphologique des Alpes de Transylvanie (Karpates méridionales), *Revue de Géogr. Annuelle*, Vol. 1, 1906-07, pp. xi-xxi (bibliography) and 1-279.

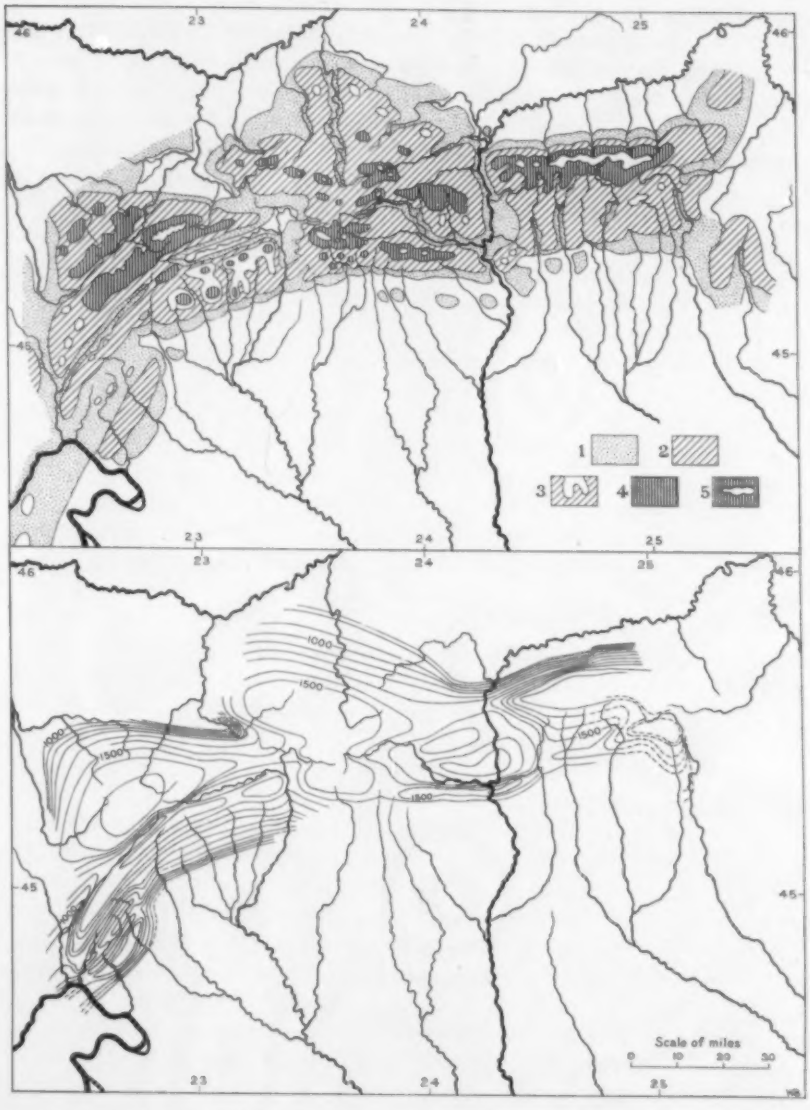


FIG. 3 (Upper)—Map showing the extent of the forms of advanced maturity developed in the Transylvanian Alps at three successive stages. Scale, 1:2,300,000. Key to legend: (1) Gornovitza platform (Pliocene); (2) Riu Ses platform (late Miocene); (3) maturely dissected Boresco monadnocks; (4) Boresco platform (probably early Miocene); (5) pre-Boresco monadnocks.

(Lower)—Map showing the present altitude of the Riu Ses platform as a result of diastrophic movements. Scale, 1:2,300,000. Interval of structure contours, 100 meters.

(Fig. 3 is redrawn from Fig. 55-56 of the author's "Recherches, etc.," cited in footnote 2.)

and extend from the Iron Gates to the Prahova River. No part of the Carpathians appears so compact. Many ridges are more than 2,000 meters (6,500 feet) high, some reaching 2,500 meters (8,200 feet), and the mean height of the summits is nearly 1,800 meters (5,900 feet). There are few longitudinal valleys, while transverse valleys, cutting the whole mountain mass, are occupied by streams which come from the Transylvanian Basin, cross the highest ridges, and flow to the lower Danube—as the Jiu (Fig. 1), the Olt (Figs. 2 and 11), and the Buzeu. These valleys are not everywhere such wild gorges as the Surduc (gorge of the Jiu) or the Red Tower Pass; and they have consequently been followed by migrating peoples and especially by strong military forces crossing the range. This was particularly the case with the Olt valley at the time of the wars between the Turks and Hungarians, and it is likewise the case in the present war.

But the most remarkable feature of the Transylvanian Alps is the flatness of most of the ridges, even when they reach an altitude of 2,000 meters (6,600 feet). Indeed the hardest climbing in these mountains has to be made, as a rule, at the beginning, over primitive pathways, while you are ascending from the valleys, which are often wild gorges and nearly everywhere remarkably profound and steepsided. But after you have reached the crest, you can walk or ride whole days on comparatively good paths in the midst of a splendid forest. When you have risen above the timber line, you travel over extensive pasture grounds, dotted, at the beginning of summer, with the most beautiful alpine flowers. This is the domain of the Rumanian shepherds; they call these heights *plaiuri*, that is to say, "the paths" (Fig. 9).

The contrast between the topographic youth of the valleys and the topographic maturity of the heights suggests the idea of a physiographic evolution involving peneplanation and rejuvenation. The geological structure of the Transylvanian Alps, as shown by the studies of Rumanian and Hungarian geologists, is alpine. The geological map shows a great extent of schists, which are referred to two series corresponding to two great overthrust masses, and a small extent of Mesozoic limestones, shales, and sandstones corresponding to an intermediary overthrust mass. Neocene beds appear only on the border and in some basins in the interior, revealing superficial folds and faults without any relation to the dislocations of the overthrust masses but sometimes in close relation to the relief and the network of valleys.

Investigations have shown that the Transylvanian Alps exhibit three series of flat-topped ridges, corresponding to three periods of more or less extensive peneplanation after the piling up of the overthrust masses which gave the range its elevated character (Fig. 3). The highest flat-topped ridges appear sometimes at 2,000 meters (6,600 feet). This surface I have called the Boresco level, from the mountain which exhibits the most remark-

able example of it (see panorama, Fig. 5). Indeed you can walk all day long in the fog on the slightly undulating plateau and cross swampy grounds with peat bogs, without knowing where you are, until the wind suddenly shifts, the fog is dispelled, and you find yourself on the verge of a valley a thousand meters deep.

The Boresco surface is very old, probably of early Miocene age, and is only preserved in some of the highest massifs. It has been much modified

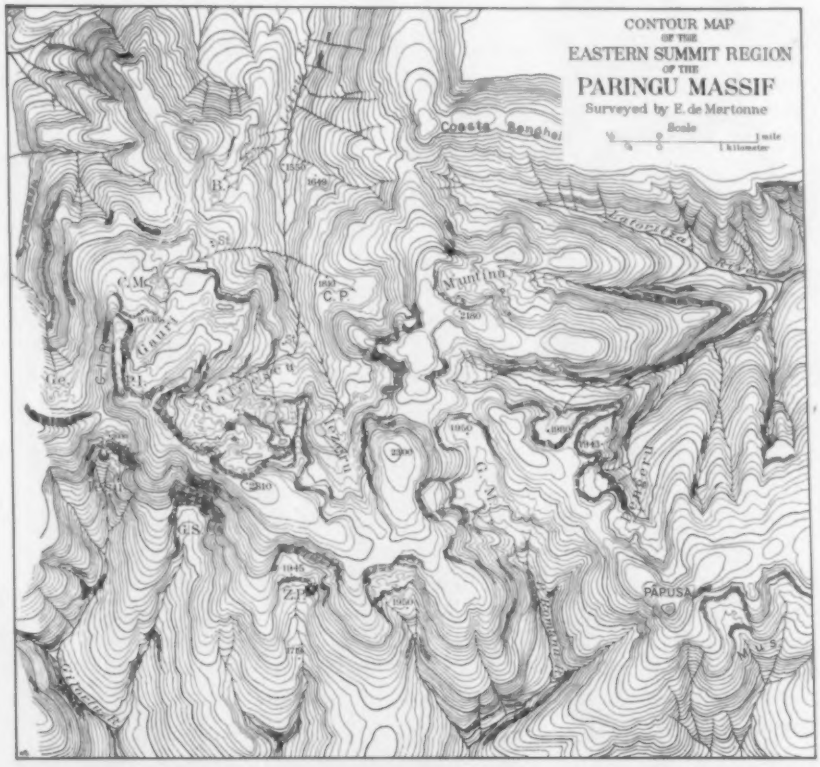
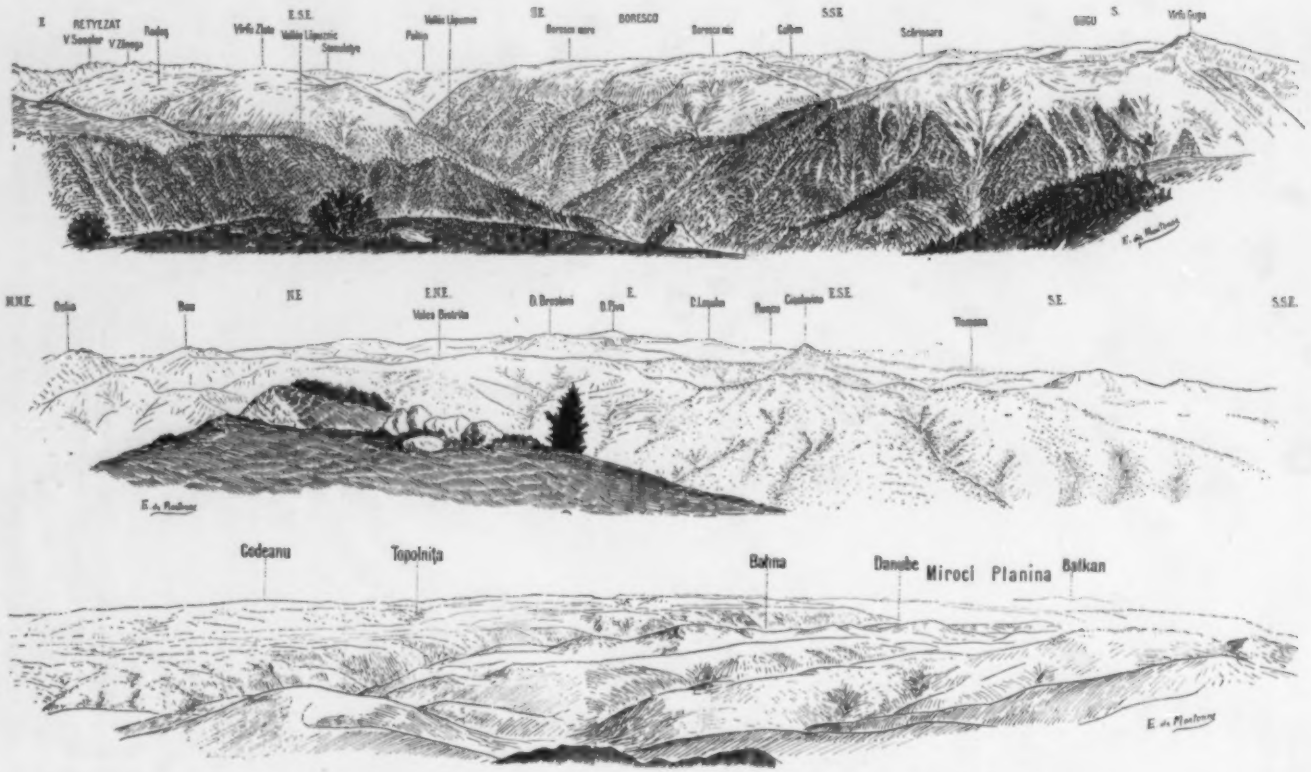


FIG. 4—Contour map of the eastern summit region of the Paringu massif, Transylvanian Alps, reduced from the author's original survey in 1:25,000, showing glacial cirques and the great extent of the Boresco platform. Scale, 1:110,000. Contour interval, 20 meters. (Redrawn from Fig. 57 of the author's "Recherches, etc.," cited in footnote 2, which consult for key to abbreviations.)

by the action of local Pleistocene glaciers. Beautiful cirques with precipitous walls, carved in the domed surface of the Paringu massif, locally give it the appearance of an alpine mountain with sharp ridges and many lakes (Fig. 4). Where the peneplanation was not completed in Boresco time monadnocks were left standing above the Boresco platform, and these have been extensively scalloped on both sides by great cirques or even by glacial valleys containing beautiful examples of trough steps and rock



FIGS. 5-7—Three panoramic views in the western Transylvanian Alps, drawn with a *camera lucida*.

FIG. 5—View showing the remarkably level surface of the Boresco, the Gugu, and the western Retiezat, and the young valleys cut in the old peneplane.
FIG. 6—View showing the continuous slope of the ridge descending to the southeast, a remnant of the Riu Ses surface, and some Boresco monadnocks.
FIG. 7—View of the Mehedintzi Plateau. Young valleys cut in the Gornovitza (Pliocene) peneplane.
(Figs. 5-7 are reproduced from Figs. 39 a and c and Fig. 33 c respectively of the author's "Recherches, etc.," cited in footnote 2.)

basins. Sharp ridges, pyramid-like peaks, and narrow passes have been developed in this way in the Retiezat and the Fogaras massifs.

The second surface from which flat-topped ridges have been derived by erosion is called the Riu Ses. It is the greatest in extent, and we may assume that it was a true peneplane surface, developed in the late Miocene, as shown by the study of its contact with the Tertiary hills in the Mehedintzi plateau. To the west of Hermannstadt it appears as a plateau dissected by many valleys into parallel flat-topped ridges which descend regularly to the north.

Where the Boresco surface is preserved over a large extent the Riu Ses surface forms young dissected esplanades, as in the Retiezat massif, or old valleys, as in the Riu Ses region itself. Sometimes Boresco monadnocks stand above it in the form of table-like reliefs, as in the Vulcan Mountains (Fig. 6).

It is on the flat-topped ridges, remnants of the dissected Riu Ses surface, that most of the old trails of the Transylvanian Alps are located. The well-known "Vulcan Pass," which has been often referred to in the present war, is not the wild gorge of the Jiu, as shown in many newspaper maps; neither is it a true pass. It is one of the *plaiuri* frequented by the shepherds. In this particular case the road follows a Riu Ses ridge which slopes gently to the south, thereby avoiding the wild gorge of the Jiu. This road was known to the Roman soldiers and merchants; and, before the building of the modern and expensive road in the Surdue gorge, it was the only means of communication between the mining town of Petroseny and the great market of Targu Jiu. Starting from the Petroseny side it is hard to reach the top, and this part of the road was strongly defended by the Rumanians in the autumn campaign of 1916. When you are once on top, on the Riu Ses surface, you can descend without difficulty to the Targu Jiu basin to the south.

The most recent surface is the Gornovitza surface, which exhibits a late-mature topography, developed on Pliocene strata. Its extent is not so great as the extent of the Riu Ses surface, and it appears ordinarily in the form of young dissected esplanades, as to the south of the Vulcan Mountains, with wild gorges cut in the Mesozoic limestones, or in the form of old valleys, now more or less dissected, making shoulders or rounded terraces above the present bottom of the young valley. The Surdue gorge is cut in such an old Pliocene valley, as is also the transverse valley of the Olt.

The whole physiography of the Transylvanian Alps, with the exception of the glacial forms of the highest Boresco summits, is explained by the extent of the deformation and dissection of the three surfaces of old maturity, developed at three different periods. Such features should influence, at least to some degree, the biogeography of the area and even its human geography. As a matter of fact, the alpine flora is richer in the Transylvanian Alps than in other parts of the Carpathians and especially

where the Boresco or Riu Ses surfaces extend above the timber line and are cut in limestone and sandstones, as in the Bucegi massif. We have already stated that the shepherds use the flat-topped ridges called *plaiuri* as pasture grounds. The great extent of these alpine and subalpine meadows and the vicinity of the steppe plains of Wallachia explain the annual migrations of the Rumanian shepherds, who spend the summer in the mountains and the winter in the plains. The sheep that are taken to the Baragan Steppe and even to the Dobrudja are often owned by peasants from Transylvania, and many of the shepherds are Transylvanians.[3] Villages recently established in the steppes of Muntenia are inhabited by Rumanian peasants from Transylvania, of whom many have been shepherds.

No one who has lived with shepherds in the mountains can fail to remark how pastoral life conduces to the preservation of old habits and peculiar customs. This makes it less difficult to understand how the Rumanians could remain a distinct people with a Latin language, while during many centuries wave after wave of barbaric invaders rolled over the plains of the lower Danube.[4]

While the flat-topped ridges extending near and above the timber line are used as pasture grounds and scattered with small, temporarily inhabited, wooden houses called *stine* (Figs. 10, 14, 15), many of the shoulders, rounded terraces, flat-topped ridges, and plateaus extending down into the forest zone below 1,200 meters (3,900 feet) are occupied by farms with meadows and orchards. In the main the villages lie near the floor of the valley; but many peasants own a small farm on a shoulder nearby, where they keep cattle in the summer. The great extent of comparatively high-standing flat-topped ridges and their use as pasture grounds by shepherds migrating to the plains of the lower Danube may be considered as one of the reasons why pastoral life has not developed in the same way as in the Alps, why so few villages are found above the valley floor, and why the limit of the permanently inhabited region is at a comparatively low elevation.

We must here note a peculiar feature of the Transylvanian Alps, the study of which not only affords evidence regarding the successive stages of deformation and erosion of the mountains but explains many interesting features of their human geography. It is what has been termed "sub-Carpathian depressions." The most conspicuous of them is the depression of Targu Jiu, which the Jiu enters when issuing from the wild Surduc gorge before cutting into the Tertiary hills of Oltenia. There are many such depressions in Oltenia and in Muntenia, appearing as a chain of flood-plains or of young dissected alluvial plains between the range itself and the wooded and strongly dissected Tertiary hills. We know that all these depressions originated as synclines on the contact of the old rock masses

[3] E. de Martonne: La Valachie: Essai de monographie géographique. Colin, Paris, 1902.

[4] E. de Martonne: La vie pastorale et la transhumance dans les Karpates méridionales; Leur importance géographique et historique, in "Ratzel Gedenkschrift," Seele & Co., Leipzig, 1904, pp. 227-245.

and the Neocene beds. Pontian marls are folded in western Oltenia; late Pliocene gravels are dislocated in western Muntenia; Pleistocene terraces are tilted and in some places broken by flexures in eastern Muntenia.

The sub-Carpathian depressions are drier and warmer than the surrounding country. They have few woods, are very well cultivated, and are more densely populated than even the Tertiary hills.[5] The villages seem prosperous. Wealthy peasants are not unknown. Every one possesses cattle, fields, and orchards; and the village community owns heavily timbered mountains with pasture grounds. It is in such places that you find Rumanian costumes in their most typical and beautiful form. History tells us that, while the peasants in the whole of Wallachia were serfs, most of the villages of the sub-Carpathian depressions were inhabited by *moshneni*, i. e., freemen, who owned their own fields and homes.

Small towns have developed in every sub-Carpathian depression, such as Targu Jiu, Ramnic, and Campulung; they lie at the head of commercial routes crossing the range. In the present war the rôle of the sub-Carpathian depressions has been quite remarkable. The defeated Rumanians rallied in the Targu Jiu depression and in the Campulung depression to check the Germans; and stubborn battles were fought at such places.

The Transylvanian Basin and the Bordering Mountains

The Transylvanian Alps are only a part of the Southern Carpathians, which form the southern border of the Transylvanian Basin.

The western border, the Bihar massif, seems to have the same geological structure and the same physiographic history as the Transylvanian Alps, although its height and extent are not so great. The Riu Ses surface seems once to have extended over the larger part of this region. The highest summits of today are probably Boresco monadnocks fringed in some cases by very small cirques. Where the old surface was cut in limestones and is dissected only by wild narrow gorges, the fields and villages are on the heights; where it is cut in schists and dissected by more open valleys, the population lives in the valleys, as in the Transylvanian Alps.

Pliocene shore lines have been discovered to the west by Sawicki.[6] They seem to correspond to the highest terraces of the Maros and to the summit of the Tertiary hills of the Transylvanian Basin. The Neocene beds are slightly undulating and even faulted in places, and it is therefore clear that the Transylvanian Basin had the same physiographic history as the smaller basins of the Transylvanian Alps, which have been more or less disturbed by the deformations of the old rock masses of the mountains. In addition they were peneplaned in the Pliocene and strongly dissected later.

[5] E. de Martonne: Recherches sur la répartition géographique de la population en Valachie. *Bull. Soc. Geogr. Romîna* (*Bukharest*), Vol. 23, 1902, No. 2 (= pp. 1-161).

[6] L. Sawicki: Beiträge zur Morphologie Siebenbürgens. *Bull. Internatl. de l'Acad. des Sciences de Cracovie: Classe des Sciences Math. et Nat., Ser. A*, 1912, pp. 130-265.

FIG. 8.

FIG. 9.

FIG. 8—The Beskidic peneplane surface of the Northern Carpathians and the first Beskidic monadnocks. (Photo by W. Lozinski.)

FIG. 9—Flat-topped ridges, called *platuri*, i.e. the paths, in the Transylvanian Alps. View taken in the Capatzina Mountains, looking west. In the background the sky line shows the level summits of the Paringu massif (high Boresco platform).

FIG. 10.

FIG. 11.

FIG. 10—Deforestation associated with pastoral life in the Southern Carpathians. In the right middle-ground a recently established *stina*, or shepherd's house; in the background the Sireu, a characteristic monadnock summit of hard conglomerates in the Moldavian flysch Carpathians near the headwaters of the Buzeu River.

FIG. 11—Transverse valley region of the Olt River: a tributary valley near the village of Titesti. Alluvial terrace with villages, fields, and orchards.

The development of such broad plains as the plains of Hatzeg, of Fogaras, and the Haromszek basin is simply the result of the rapid erosion of the soft Levantine beds. The stages of erosion are clearly shown by the terraces.[7]

The physiography of the mountains bordering the Transylvanian Basin in the east has not yet been worked out. We only know that the Hargitta is a complex volcanic mass, in which the original slopes may easily be reconstructed, and which has blocked the upper valleys of the Maros and the Olt, forming the basins of Gyergyö and Csik.[8] It lies at the very place where one would expect to find the continuation of the Transylvanian Alps, by following the strike of the schists, and shows how much breaking and sinking is responsible for the outline of the Southern Carpathians. The Rodna Mountains are a remnant of those old masses, and appear as the duplicate of the Fogaras Mountains in the Transylvanian Alps, a bold, heavily timbered, strongly glaciated alpine chain, with cirques and small troughs.[9]

The greater part of the Moldavian Carpathians, which are built of closely folded flysch sandstones, still awaits physiographic investigation. On several reconnaissance tours I gained the impression that the highest summits, formed of conglomerates and hard sandstones, are Riu Ses monadnocks, and that most of the round ridges are derived from the maturely dissected Gornovitza surface. Interesting facts would certainly be brought to light by studying the sub-Carpathian depressions, which here may better be called intra-Carpathian depressions, for they are separated from the plains and hills of Moldavia by a belt of folded sub-Carpathian ridges.

Surrounded by mountains, the Transylvanian Basin has a dry and extremely continental climate. The winters are particularly severe in the plain of Kronstadt; the summers are exceedingly hot. A loam similar to the loess of southern Russia is found nearly everywhere on the slopes of the hills. The flora of the region called Mezöseg, north of the upper Maros River, is steppelike in character.

It is rather curious to see how the Magyars, coming from the great Hungarian plain, entered the Transylvanian Basin, followed the broad valleys with the loess terraces, and established themselves in the dry plains of Mezöseg and in the Haromszek basin, where you find their large villages and their bighorn cattle. The Rumanians, however, remain the dominating race and show such a power of expansion that they have completely assimilated many Magyar villages and nearly all German colonies. In addition they have been able to cross the mountains and contribute to the colonization of the plains of Wallachia and Dobrudja.

All that we know of the Southern Carpathians goes to show that they are very different from the Alps. The piling up of the overthrust masses

[7] E. de Martonne, paper cited in footnote 2, pp. 213-216 and 225-227.
[8] L. Sawicki, *op. cit.*, pp. 259-262.
[9] *Ibid.*, p. 160.

occurred probably at an earlier time. The main physiographic features are the result of downwarping and upwarping, of partial peneplanation, and of a more or less complete dissection of old mature surfaces according to the hardness or softness of the strata.

The human geography of the area is not less peculiar than the physiography and is partially controlled by the physiographic features. Pastoral life with extensive migrations is a typical feature and may account for the preservation of the Rumanians as well as their extension over Transylvania and Wallachia.

The Northern Carpathians

Geological and topographic mapping has been more completely carried on in the Northern Carpathians than in the Southern. However, physiographic investigation has only begun, and much remains to be done to understand the development of the relief.

The most striking feature is the contrast between the outer belt of parallel ridges, apparently regularly folded flysch sandstones, and the inner belt, exhibiting the most confusing alternation of isolated small massifs and more or less closed basins of highly complicated geological structure: schists and granite, Paleozoic and Mesozoic layers, flysch, and even large volcanic masses.

The outer belt may be called the Beskids. We know from borings in Wielicz that their structure is not so simple as it appears and that we have to do with overthrust masses advancing over the Neocene beds to the north.[10]

The physiographic studies of Sawicki[11] have shown how the slightly undulating surface to the south of Cracow is a peneplane of Miocene age, above which stand some monadnocks (Fig. 8). Southward the surface rises, the monadnocks become more strongly developed, making parallel ridges, while the surface continues in the form of a network of old valleys. From the statements of Sawicki one may infer that this surface was formed in the Riu Ses cycle of landform development, but it has been partially downwarped, and buried under Neocene sediments, to be exposed again by the removal of the soft beds covering it.

Whatever may be its history, this peneplane is a striking feature of the Beskids, dissected as it is by comparatively wide valleys, except where it is cut on limestones. The network of old valleys was followed by the Slav colonization coming from the north. Woods were cleared, small villages established, and little houses built here and there along the rivers or on the edges of the shoulders representing the floors or sides of the old Miocene valleys. But the woods on the ridges everywhere remain intact. There is a striking contrast between the densely timbered monadnock ridges with their com-

[10] V. Uhlig: Über die Tektonik der Karpathen, *Sitzungsber. der Kais. Akad. der Wiss.-Wien: Math.-Naturwiss. Klasse, Abt. I*, Vol. 116, 1907, pp. 871-982.

[11] L. Sawicki: Die jüngeren Krustenbewegungen in den Karpathen, *Mitt. der Geol. Gesell. in Wien*, Vol. 2, 1909, pp. 81-117.

paratively steep slopes and the smoothed surfaces covered with fields and meadows and dotted with villages and farms. Southward still farther the old Miocene surface does not rise over 900 meters (3,000 feet), and this is the reason why the inhabited zone is so low in the Beskids. The tops of the highest ridges stand only 100 or 200 meters (330 to 660 feet) above the timber line and can be used as pasture grounds in the summer. Cattle raised in the neighboring valleys are found in every suitable place. But this is nothing as compared with the extensive migrations of the Rumanian shepherds in the Southern Carpathians.

The inner belt of the Northern Carpathians, which may be called the Hungarian Alps, is the most confused part of the whole Carpathian range. Lugeon has shown that it has an overthrust structure, the detail of which has not been worked out.[12] But the topography can only be considered as the result of downwarping and faulting.

Some massifs are flat-topped and resemble the Boresco surfaces in the Southern Carpathians; but they appear at different heights, separated by broad basins, so that only very accurate physiographic studies would yield evidence regarding the ages and the relations of such surfaces.

The highest massifs have been strongly glaciated and are bordered by cirques with large lakes, beautiful troughs, and small hanging valleys, derived from young preglacial torrential valleys. Such is the case with the Tatra, which is a true alpine chain with sharp ridges and precipitous peaks. Other massifs, such as the Nizna Tatra and the Fatra, are simply fringed by small cirques like the Boresco ranges in the Southern Carpathians and still preserve high rolling surfaces which can be used as pasture grounds.

The basins are not directly due to downwarping and faulting. They ordinarily show a succession of terraces, of which the highest are developed in the form of an esplanade, in many cases entirely surrounding the depression and corresponding to a divide between two neighboring basins. Such esplanades are commonly built on Neocene strata, more or less faulted, or of strongly folded flysch. It seems that the basins have been recently re-excavated after having been peneplaned, like the Petroseny and other small basins of the Transylvanian Alps, probably at the time at which the Transylvanian Basin itself began to be dissected again. The sinking of the Hungarian plain may have contributed to increase the erosive power of the tributaries of the middle Danube. Some captures resulted from this process, the most striking example being the capture of the upper Arva by the Waag.

The contrast found in the Beskids between the densely populated old Miocene surface and the wooded monadnock ridges is not less striking here between the massifs and the basins. The break of slope at the contact of the

[12] M. Lugeon: Les nappes de recouvrement de la Tatra et l'origine des Klippes des Carpathes, *Bull. Soc. Vaudoise des Sci. Nat.* (*Lausanne*), Ser. 4, Vol. 39, 1903, pp. 17-63.

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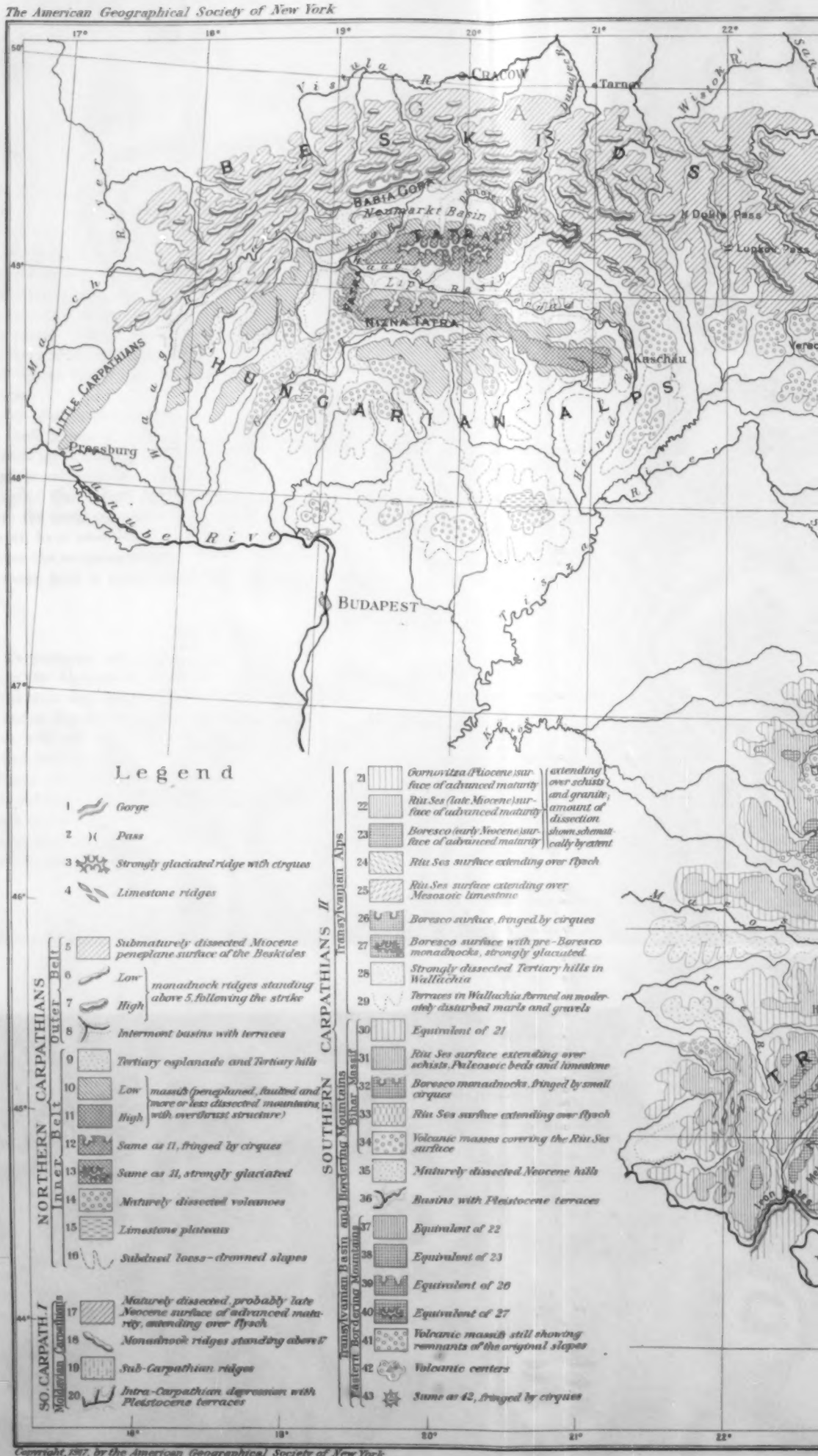

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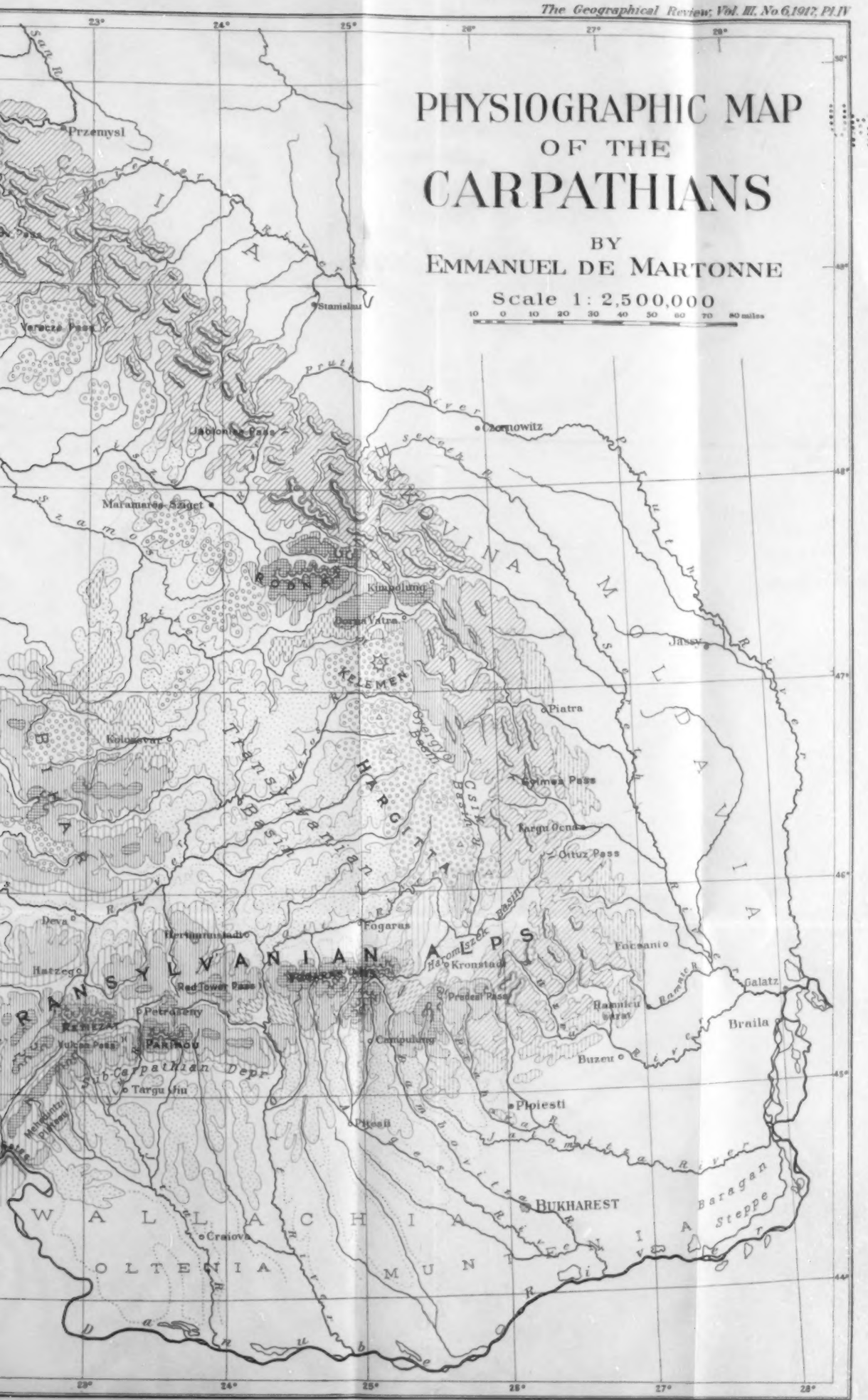
PHYSIOGRAPHIC MAP
OF THE
CARPATHIANS
BY
EMMANUEL DE MARTONNE
Scale 1: 2,500,000
10 0 10 20 30 40 50 60 70 80 miles
Przemysl
Stanislau
Vereczke Pass
Jablonitza Pass
Czernowitz
Maramaros-Sziget
Kimpolung
Dorna Vatra
Jassy
Piatra
Kolozsvar
Oituz Pass
Deva
Fogaras
Hermannstadt
Kronstadt
Focsani
Galatz
Braila
Petroseny
Campulung
Buzeu
Ploiesti
Pitesti
BUKHAREST
Craiova
Sub Carpathian Depr.
Baragan Steppe
Danube
Dniester
Pruth
Sereth
Szamos
Maros
Aluta
Jiu
Ardjish
Dambovitza
Prahova
Rimnicu Sarat
Predeal Pass
Red Tower Pass
Vulcan Pass
Hatzeg
Retezat
Parang
Transylvanian Basin
Transylvanian Alps
Bucovina
Moldavia
Wallachia
Oltenia
Muntenia
Carpathians
Kelemen
Hargitta
Csik
Orsova
A. Hoen & Co.

massifs and the basin floors is emphasized by a change in the vegetation. A dense forest of fir and beech trees covers the mountain block. On the esplanade, where the light oak forest has been cleared, pasture grounds and some fields occur; but the bulk of the cultivated and inhabited zone is found in the basins. There are a few points in the mountains where the forest has been cleared and settlements of German mining colonies are found at heights of about 1,000 meters (3,300 feet). The highest basins, such as the Neumarkt basin to the north of the Tatra and the Lipto basin to the south, were late in being settled; here Germans founded small towns and built a dense network of agricultural villages. The scattered villages of the Slavs, on the other hand, everywhere occupy the lowest parts of the basins, with fields extending over the terraces. A map of the density of population would emphasize the distinction between the mountain blocks and the basins and would at the same time be a good orographic map.

The southernmost part of the Northern Carpathians is the most shattered. Extensive volcanic masses have been poured out since the early Miocene, covering almost entirely the few remnants of the old folded mountain range. The whole area appears to have been partially drowned by the sinking of the Hungarian plain. Instead of nearly enclosed basins, with terraces, we find broad, open depressions rising by continuous slopes to flat domes.

The dry climate of the plain, marked by clear days, affects the whole region. Dark brown or black soils are found on the lower parts, and the loess extends up to a height of 400 meters (1,300 feet) on the gentle slopes. The Magyars are here as much at home as in the Alföld, the great Hungarian plain. One cannot fail to remark the contrast their large villages make with the small scattered houses of the Slav peasants. They cultivate more wheat, have more cattle, and especially large herds of swine. Vineyards cover the southern slopes.

The range here is more widely open; it almost vanishes in the plain.

Conclusion

The Carpathians may hardly be considered a geographical unit, in contrast to the Alps, which stand as a bold and solid mass, though a large area in the west was drowned in the plain of the Po, and downwarped or faulted basins fringe the eastern extremity, facing the Hungarian plain.

Not so with the Carpathians. They are a much-shattered mountain system, and this shattering seems to have begun very early. The Transylvanian Basin, with its great extent of Neocene layers, was certainly formed just after the first uplift of the range, and probably looked, in late Neocene time, much as does at present the great embayment of the Hungarian plain near the headwaters of the Tisza, by which the Carpathian bow is almost completely broken in two.

FIG. 12.

FIG. 13.

FIG. 12—Decorated entrance to a house in the village of Bumbesti, sub-Carpathian depression of Targu Jiu. Dwelling on the right, stable on the left, orchard in the background.

FIG. 13—House in the village of Bumbesti.

FIG. 14.

FIG. 15.

FIG. 14—Pastoral life in the Transylvanian Alps: a *stina*, or shepherd's house, in the Fogaras Mountains above timber line. Sheep corral on the left, cheese hut on the right.

FIG. 15—Pastoral life in the Transylvanian Alps: a *stina* near the timber line, Paringu massif.

The general scheme of evolution of alpine mountains may be approximately outlined as follows:

(1) Folding, with overthrusting, accompanied or soon followed by uplift.

(2) Erosion and partial or complete peneplanation.

(3) Shattering, by downwarping and faulting, of more or less extensive parts of the mountains.

(4) Uplift accompanying or following the shattering, with erosion and more or less extensive glaciation.

The physiographic features depend chiefly upon the relative importance of these episodes and upon their more or less close succession.

In the Alps the succession has been a very rapid one, so that it is difficult to discern the features due to each episode. The special importance of the last episode has been recognized only in recent years. Uplift is more important than stream erosion.

The development of the Carpathians was slower. Shattering was more important than uplift. The result is that we can recognize much better the forms due to the successive cycles of erosion, especially in the Transylvanian Alps. Flat-topped or subdued summits are dominant. The mean height is very great compared with the maximum height of each massif. Only local glaciers were formed in Pleistocene times, and true alpine ridges are not a common feature.

As a whole, the Carpathians are an open mountain system, with wide, old valleys, as for instance in the Beskids; many small basins, as in the Hungarian Alps and in some parts of the Transylvanian Alps; extensive basins, as the Transylvanian Basin; or even great embayments of the plain penetrating into the very heart of the mountains, as the upper Tisza plain.

The influence of these features on the biogeography and human geography of the region is very apparent.

The subalpine and alpine flora of the Southern Carpathians is in many respects different from the flora of the Northern Carpathians. As a whole the Carpathians are not so heavily timbered or so densely inhabited as the Alps. But while the mean of the uninhabited surface is probably about 60 per cent in the Alps, it is certainly less than 50 per cent in the Carpathians. Man does not need to climb so high; wide valleys or basins are everywhere open to settlement.

The Alps were not able to check the advance of the peoples invading Europe, but they deflected the waves of the invaders to the north and to the south. They have been penetrated by the Slavs and the Germans, though they still form the limit of various languages and nationalities.

The Carpathians not only have been crossed by invaders on various occasions, but, instead of playing the rôle of a wall separating different

peoples, they have served as the center of development of certain nationalities. This is particularly true of the Southern Carpathians, in which we find the citadel of the Rumanians.

In the present great war, the Carpathians, standing between the two groups of belligerents, have been crossed at the north by the Russians and at the south by the Rumanians invading Transylvania and by the Austro-Germans invading Rumania.

The reader is not to gain the impression that the writer believes all features of human geography to be controlled by physiographic conditions. A complete study of the human geography of the Carpathians would involve many considerations that it is not the intention of the writer to present here, and particularly much history. Physiography affords possibilities which are realized by man in varying degree. Certainly there are in the Carpathians some remarkable evidences of the control exercised by the physiographic features upon the development of human activity. Nevertheless the writer does not wish to imply that this human activity developed as it did merely because of what the physiographic history of the range has been, but rather that it could not have been what it is if the range had been built otherwise.

THE CONQUEST OF RUMANIA

By DOUGLAS W. JOHNSON

When in the summer of 1916 Rumania abandoned a position of wavering neutrality and cast in her lot with that of the Entente Allies, the hopes of the Allied powers rose to high levels. Justification for these hopes lay not so much in the fact that Rumania possessed an army reputed to be better trained than that of any other Balkan state, but rather in the advantageous geographic position which the new ally enjoyed. Her two provinces of Wallachia and Moldavia lay like the jaws of an open nutcracker, between which Hungarian Transylvania could be crushed as in a vice. Her peculiar outline added some 800 miles to the length of a battle line already too long for the declining man power of the Teutonic allies. Her western border lay but 40 miles northeast of the Morava-Maritza trench, carrying the Orient Railway, that vital artery which alone assured continued life to the Turkish Empire. Her oil fields and her wheat fields were added to the material resources of the Entente and closed to their sorely beset enemies. Small wonder that Rumania's decision was hailed with delight by the Entente powers.

A few months later all their high hopes lay in the dust. The Wallachian jaw of the nutcracker had been rudely wrenched away. Rumania, not Transylvania, had been crushed. Eight hundred miles of new battle front had been shortened to less than 300 miles. The Orient Railway was still carrying munitions to the Turks. Oil fields and wheat fields were supplying Teutonic conquerors, and the German Chancellor was grandiloquently offering terms of peace to his disappointed foes.

The Rumanian campaign was disconcerting not alone to those most vitally interested in its consequences. The unexpected happened with such regularity that disinterested onlookers found ample need to revise their most confident predictions. More than one military expert would gladly delete whole paragraphs from his published discussions of the campaign and forget prophecies which events failed to justify. From the writings of one such unfortunate there would have to be erased the assurance that the only danger to Bukharest was from the east through an attack from Dobrudja; that no serious attempt would be made to invade Wallachia by way of the passes of the Transylvanian Alps; later, that the Buzeu River was the main defensive line to which the Rumanians were retiring; still later, that this main line was the Sereth-Trotus valley; and finally, that the Sereth-Putna barrier (which proved to be the impassable obstacle to pursuit) was not adapted for defensive purposes.

The key to the Rumanian puzzle is in part geographical, in part political. In the following pages it will be our purpose, first, to analyze the geographic elements of Rumania's surface configuration and strategic position; second, to determine what plans of campaign were dictated by her geography and how far these plans were modified by political considerations; and, third, to trace the effect of land forms upon the detailed movements of armies throughout the campaign. If in the course of this analysis we find a logical explanation for the unexpected and disappointing events in Rumania, our first aim will have been achieved. If, further, we gain therefrom a knowledge of Rumanian military geography which will enable us to interpret future movements of the Allies in attempting to expel the invader, our study will have proved doubly profitable.

The Natural Defenses of Rumania

Few countries are so richly supplied with natural protective barriers as is Rumania. The entire eastern border is shielded by the Pruth River and the Black Sea, the northern and western by the Transylvanian Alps, the southern by the broad marshes of the Danube. Only in the southeast, for a distance of about 100 miles, is there a dangerous gap in the defensive line, the southern border of the province of Dobrudja. Those portions of the border of interest in the present connection are the Transylvanian Alps, the Danube valley, and the unprotected Dobrudja gateway.

The Transylvanian Alps. From the border of Bukovina to the Iron Gates of the Danube the Transylvanian Alps form an unbroken mountain barrier, protecting the low Rumanian plain on the east and south from hostile invasion. They are a direct continuation of the Carpathian Mountains[1] on the north and beyond the Danube connect with the western end of the Balkan Range. Northwestward the mountainous topography is continued by the Hargitta and Bihar masses of Hungary, but in Wallachia and Moldavia the Transylvanian Alps drop down to low foothills, which are in turn bordered by the broad plain, sloping southward or eastward to the Danube. They have an average breadth of some 50 miles or more and usually consist of a main range, bordered on the Rumanian side by secondary ridges or hills, sometimes with a lowland intervening between the two. In the Moldavian sector the secondary crests consist of parallel ridges much like those of the northern Carpathians, and remind an American of the genetically similar Appalachian ranges. It is clear that an invader who succeeded in passing the main range would still have hard fighting before him if he would pierce the secondary defensive barrier and reach the plain beyond.

[1] The dividing line between Carpathians and Transylvanian Alps is variously drawn. De Martonne places it west of the great bend in the range, while others place it north of the bend, near the Bukovina border. For purposes of practical convenience in the present discussion we will use the single term "Transylvanian Alps" for the entire range bordering Rumania.

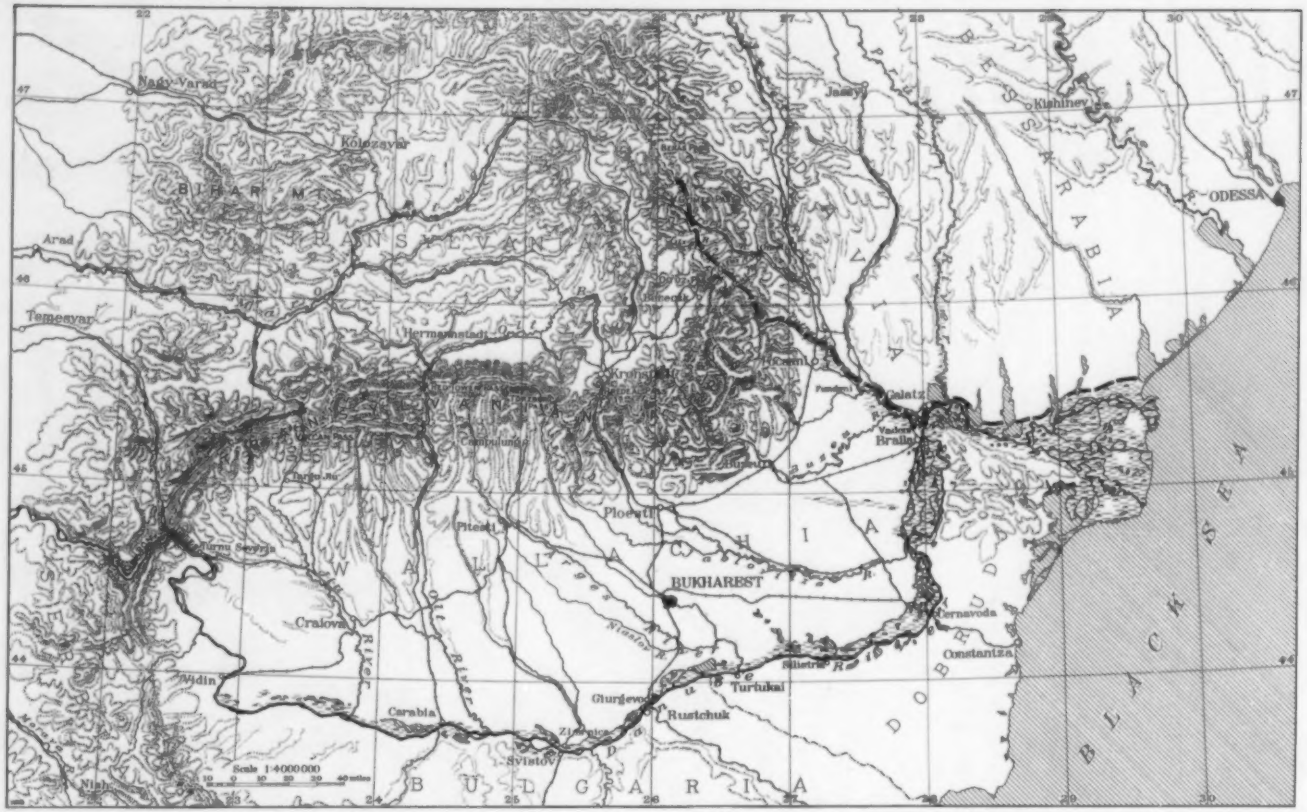

FIG. 1—Map showing the chief natural defensive barriers of Rumania. Scale, 1:4,000,000.

The broken line indicates the approximate position of the Russo-Rumanian front back of the Sereth-Putna barrier at the close of the campaign, early in February, 1917. The position of the front is not extended to the top of the map because of lack of specific information. (Note: For "Jablovitza River," in 44½° N. and 27° E., read Jalomitza River. The unnamed river debouching at Fundeni, in 45½° N. and 27½° E., is the Ramnic River.)

The use of the name Alps in connection with the Transylvanian mountains should bring to the mind of the reader the broad upland meadows from which the Alps of Switzerland get their name, rather than the rugged and inaccessible peaks which one is more apt to associate with Swiss scenery. In the Moldavian or northern part of the Transylvanian Alps the summits are comparatively low and more or less even-crested, suggesting an upwarped and dissected peneplane surface, usually less than 5,000 feet above sea level. Even here dissection to a fairly strong relief gives a rugged topography difficult for an army to traverse. Along the northern boundary of Wallachia the mountains rise to heights of 8,000 feet and over, while local glaciation has left its traces in steep-walled cirques and peaks of more truly alpine type. Broad upland remnants are nevertheless a predominant feature of the landscape, and De Martonne distinguishes several distinct erosion surfaces or partially developed peneplanes. Evidently the Transylvanian Alps must be characterized as a difficult mountain barrier, but do not deserve the adjective "inaccessible." When one remembers that they are in large part covered by forests, their difficult nature from the standpoint of military geography is better appreciated.

Nine passes of military value afford opportunity for troops to cross through the Transylvanian Alps. For strategic reasons it is preferable to consider these in three separate groups. We may denominate "the northern passes" those lying north of the great bend in the range. Farthest north is the Bekas Pass, crossed by a wagon road. At Gyimes Pass, both railroad and wagon road unite the two sides of the mountains. A good wagon road crosses through the Oituz Pass, while farther south another road or trail of inferior quality takes advantage of a less important gap. The "central passes" include two of first importance: Predeal, or Tömös, Pass, carrying the railroad and highroad from Bukharest to Kronstadt; and Törzburg Pass, crossed by a first-class wagon road. Of the three "western passes" the Red Tower Pass is the most remarkable, consisting of the deep, narrow gorge of the Olt River, cut entirely through the mountain barrier and carrying the railroad and highroad from western Rumania northward to the important Transylvanian town of Hermannstadt. Farther west the narrow gorge of the Jiu River, often referred to as "Vulcan Pass,"[2] is traversed by a wagon road alone, while the pass of the Iron Gates, cut by the Danube River, is occupied by both road and railway.

A fact of no small military importance is this: every one of the northern passes, and every one of the western passes, consists of the gorge or valley of a stream which rises on the Hungarian side of the international boundary and flows down-valley into Rumania. In other words, these passes are not

[2] The Vulcan Pass sheet of the Austro-Hungarian topographic survey shows Vulcan Pass proper on a broad, flat-topped upland forming the summit of the range, crossed by a trail a few miles west of the Jiu gorge. It is the gorge, however, which carries the wagon road, which has in fact become the real pass since the road was constructed, and which is referred to when the name "Vulcan Pass" is used in the following pages. [Cf. Professor De Martonne's paper, p. 425, above.—EDIT. NOTE.]

FIG. 2—Typical view in the Transylvanian Alps, showing railroad and highway at Sinaia running south from Predeal Pass. (Photo copyright by Underwood & Underwood.)

cols or saddles at the crest of the range, but portions of narrow valleys where these chance to be crossed by the political boundary. All of the valleys facilitate the movement of hostile troops in the easier direction, downstream, into Rumanian territory.

The Danube Valley. From the Iron Gates to a point southeast of Bukharest the Rumanian plain is protected by one of the most remarkable river barriers in the world. The Danube is in itself a great stream, half a mile or more in breadth and very deep. For much of its course it has a braided pattern, being split into two or more channels separated by intervening marshy flats. But of more importance is the broad belt of marsh and lake which borders the stream on either side, especially the northern side, and which varies in width from three to six miles, occasionally attaining a breadth of a dozen miles or more. The lakes are in part abandoned oxbow lakes and in part bodies of stagnant water filling lower portions of the backswamps or depressions between two sets of natural levees built by the river at different periods. Many lakes are covered in whole or in part by floating bogs, the broader marshes of the lower Danube, known as the Balta, being peculiarly treacherous and difficult to traverse.

Such a belt of marshy floodplain, dotted with lakes and traversed by one or more channels of a great river, constitutes a formidable barrier even in times of peace; and between Belgrade and Cernavoda, a distance of 500 miles, not a single bridge spans the Danube. Even where important railways reach neighboring towns on opposite sides of the stream, travelers must make the transfer by ferry. For military purposes the situation is only slightly relieved by the fact that occasional tongues of dry land come to the water's edge, facilitating in some small degree a forced crossing. At the most favorable places, however, no troops could force a passage in the face of an enemy equipped with proper artillery and abundantly supplied with munitions.

The Dobrudja Gateway. From the Danube southeast of Bukharest to the Black Sea the Rumanian border consists of the southern boundary of Dobrudja. This is the only significant portion of the Rumanian frontier which is not formed by some natural topographic obstacle. It is absolutely unprotected. An open plain, somewhat more dissected near the Danube, is traversed by an artificial line of demarcation which is unrelated to any topographic feature. Here is an open gateway, a hundred miles wide, through which a Rumanian army might debouch with ease upon Bulgarian lands, or by means of which Rumania might itself be readily invaded. Only an opposing army of greater strength can close such an opening against enemy attacks.

The Plans of Campaign

The geographic position of Rumania, considered in connection with the physiographic character of her frontiers, permits certain deductions

as to possible plans of campaign. In the first place, it is evident that the moment Rumania entered the war a dangerous salient was necessarily imposed upon the new Teutonic front. The Hungarian province of Transylvania formed this salient, with its apex at the great bend in the Transylvanian Alps. To crush in the sides of such a salient is a favorite military manœuver, and in the present case this might be done by Rumanian armies advanced through the northern and western passes.

Southwest of western Wallachia the Morava-Maritza trench lay not far distant, and through this trench passes a railroad of the most vital importance to the Central Powers. Some critics suggested an advance across the Danube to cut this artery of Turkish life. It will be noted, however, that Wallachia forms a salient projecting into the Teutonic front, just as Transylvania projects into Rumanian territory. Already this salient was of dangerous proportions. To increase the danger by extending the apex forty miles farther into hostile lands would invite disaster.

The open Dobrudja gateway lies much farther from the coveted Orient Railway, but the distance is not prohibitive for a military campaign of the first magnitude. Secure in the possession of the Cernavoda bridge over the Danube, supplemented perhaps by other temporary pontoon bridges, a large Rumanian army might assemble in Dobrudja and then push southwestward through the gateway. Extending its front as it advanced, it could rest its left flank on the sea, where Russian control assured a safe supply line, and its right flank on the marshy plain of the Danube. Such a manœuver possesses several noteworthy advantages: it starts with control of a safe passage of the Danube, which effectively turns that obstacle and enables the advancing Rumanians to flank the Teutonic allies out of their protected positions; it progressively straightens out the dangerous Wallachian salient; it provides a safer, if longer, advance to the Orient Railway; and it looks forward to a possible junction with Sarrail's Saloniki army and the severance of Turkey from her European allies.

Rumania did not possess sufficient troops to undertake two big campaigns at the same moment. She had to choose between the invasion of Transylvania through the mountain passes, and the invasion of Bulgaria through the Dobrudja gateway. Geographic conditions clearly demanded that she choose the latter alternative. With a minimum of troops she could hold the Teutons at bay in the narrow passes, and throw her main strength into the Dobrudja campaign, which promised such gigantic returns as the destruction of the Orient Railway, the possible capture of Constantinople, and the elimination of Bulgaria and Turkey from the war. On the other hand, an invasion of Transylvania would have only local results in the capture of certain territory and would indeed better the strategic position of the Teutonic allies by shortening their line. It could scarcely hope to eliminate any nation from the war, and could only eliminate a large fighting force in case the Teutons were unable to prevent the crushing of the

salient before their armies had withdrawn from before the central passes. While such a campaign in Transylvania was in progress, there would be real peril that a Teuton army would enter Rumania through the open Dobrudja gateway; for Rumania could hardly concentrate sufficient troops for a vigorous offensive in the difficult mountains of Transylvania, where every topographic advantage lies with the defensive, and at the same time spare the great body of troops required to block an unprotected gateway 100 miles in width.

But now there enter political considerations, the *bête noire* of the strategist. Transylvania was a lost province which Rumania was pledged by the terms of her declaration of war to redeem. Enthusiasm for the war would be aroused more by an invasion of the coveted region, than by a campaign in Bulgaria, the remoter objects of which would for a long time be obscure to the masses of the people. If Rumania invaded Bulgaria, Russia might overrun Transylvania; and Rumanians did not want Russian troops in her lost province when terms of peace were discussed. Hence came the decision which placed political considerations above considerations of military geography, and which constituted the first factor in the tragedy of Rumania.

For her part, Germany, the controlling genius of the Central Powers, permitted no political considerations to warp the plans for dealing with the Rumanian menace. She prescribed a plan of campaign which involved deliberate sacrifice of large areas in Transylvania to the impatient grasp of Rumania, and gathered strength for an assault on the Dobrudja gateway which should effectually close the way to any future menace to Bulgaria from that quarter. Let us now trace the history of the Rumanian campaign and note the rôle of physiographic features on the detailed movements of the army.

Strategic Geography of the Campaign

Promptly upon Rumania's declaration of war her troops seized the passes through the Transylvanian Alps and began the invasion of the coveted province. Columns operating through Predeal and Törzburg Passes converged on the important city of Kronstadt, while an independent column, debouching from Red Tower Pass, captured Hermannstadt. Without opposing serious resistance to the invaders, the Teutonic armies fell back toward the northwest, shortening their battle front and at the same time permitting the Rumanians to extend their thin lines of communications from the passes into the mountainous country beyond. As the Teutons fell back toward the good lateral supply line formed by the railroad and highroad traversing the Maros valley, their powers of resistance increased simultaneously with the weakening of the Rumanian offensive, especially since the Rumanians were now compelled to transport

munitions and supplies through a limited number of narrow mountain passes and far into the difficult country to the northwest.

When the advantage in favor of the Teutons had reached the desired proportions, they fell upon the Rumanian columns with overwhelming power, broke their resistance with superior accumulations of artillery and shell, and drove them back into the passes. Where opportunity offered, the thin supply lines were assailed and retreats compelled by threats to, or actual severance of, these lines. The column operating north of Hermannstadt depended upon the road and railroad through the Red Tower Pass. A small Teutonic force, operating over rough trails through minor valleys in the mountains, succeeded in reaching the pass far in the rear of the Rumanian front and actually cut the railway upon which the existence of the column depended. Abandoning large stores of supplies to the enemy, the Rumanians made a precipitate retreat, cut their way through the small flanking force, and re-established themselves in a position on the Rumanian side of the border. In a short time all the Rumanian columns were back in the passes, fighting desperately to prevent a Teutonic invasion of their own country. The unfortunate Rumanian plan of campaign had collapsed.

Meanwhile the second step of the Teutonic plan was well under way. Von Mackensen, with superior forces, entered the open Dobrudja gateway. What was his object? This was a question which claimed much attention from military critics. Some were convinced that he was chosen to deliver the death blow to Rumania by pushing northward to the Cernavoda bridge, crossing by it to the main Rumanian plain, and taking Bukharest from the east. Geographic conditions were all against such an interpretation. At Cernavoda the marshy plain of the Danube is nine miles broad and the river splits into two main channels. In addition to two long bridges over the river channels, a third bridge spans one of the numerous lakes in the marsh, while the intervening spaces are traversed by high embankments or viaducts. The so-called Cernavoda bridge is thus nine miles long, consisting of three bridge sections and two viaduct sections. Von Mackensen could not expect to capture this bridge before its destruction; its destruction could be rendered absolutely complete; and without it no safe and satisfactory line of communication over the marshy barrier was feasible. Furthermore, an attack on Bukharest from the east would necessitate a line of communication so excessively long and roundabout that the flow of shell to the battle front could scarcely be maintained at a rate sufficiently rapid to insure victory for Teuton arms. Geographic conditions imposed a supply line too long and too thin to permit a principal offensive by von Mackensen's army.

On the other hand, geographic conditions demanded an important offensive in this region for the achievement of certain necessary ends. So long as the Dobrudja gateway remained open it was a serious threat to

Bulgaria, the Orient Railway, and the continuance of Turkish support. Rumania might recover from the folly of her invasion of Transylvania, and with Russian aid undertake a belated offensive in the right direction. Teutonic armies must, therefore, close the gate. This could be done by a large force, entrenched on or near the boundary, with its right flank protected by the sea and its left by the Danube marshes. But why entrench on a front one hundred miles long when an invasion of Dobrudja, pushed only seventy miles northward, would reduce the necessary front to less than a third that length?

Dobrudja is shaped like an hour glass where the Danube River and the Black Sea coast bend toward each other. The narrowest part of the constriction lies north of the railroad which crosses the Cernavoda bridge and connects Bukharest with Rumania's only seaport, Constantza. An invasion of Dobrudja would, therefore, upset Rumanian plans for an invasion of Bulgaria, would add a certain amount of territory to the Teutonic holdings, would sever Rumanian intercourse with her Russian ally by way of the Black Sea, would result in the destruction of the only bridge which made possible an effective turning of the Teutonic positions south of the Danube barrier, and would enormously reduce the number of Teutons required to stop the gateway through which alone a dangerous Rumanian offensive could move. If von Mackensen could clear all of Dobrudja of Rumanian and Russian forces and place the barrier of the lower Danube from Galatz to the sea between himself and his enemies, he could prevent a recrossing of the river by leaving small screens of troops at critical places, and might then withdraw his main army for use elsewhere. The fact that von Mackensen, one of Germany's best generals, was placed in command of this invasion, proves that the German general staff appreciated the high importance of the move. The fact that Rumania wasted her strength elsewhere and even left an inadequate defensive force at the gateway, suggests that some one high in her authority made a fatal blunder.

Von Mackensen began the invasion by moving his principal columns northeastward close to the Danube River, possibly because the calcareous formation of the Dobrudja plain leaves little water on the surface, and water in large quantities was needed for his troops. Turtukai and Silistra were taken and their defenders captured or driven to the north bank of the Danube. On a low ridge a dozen miles south of the railroad to Constantza the Rumanian armies, with Russian reinforcements, made a stand. They succeeded in holding von Mackensen's main force in check while a violent assault on his weak right wing, nearer the sea, pushed that part of the Teuton line back to the southward a day's march. Late in October von Mackensen heavily reinforced his right wing and made a second try on that end of the battle line. The manœuver was completely successful. Constantza was captured, and the danger of an outflanking operation compelled the Russo-Rumanian army to uncover the Cernavoda

bridge. Part of the defending force apparently escaped across the bridge before it was destroyed, while the remainder withdrew into northern Dobrudja, pursued by the Teutons. After a long campaign in the more hilly country of the north, where topographic conditions prevented a rapid offensive, the last of the Russo-Rumanian troops crossed to the farther bank of the Danube, leaving the enemy in undisputed possession of all Dobrudja. The Dobrudja gateway was effectively closed and securely locked.

It should be noted that throughout the Dobrudja campaign the Teutonic armies operated with their left flank exposed to the Rumanian armies west of the Danube, and their right flank exposed to the Russian fleet controlling the Black Sea. By "exposed" is meant that, if we disregard physiographic barriers, the Teuton line was completely outflanked at both ends and its position was impossible. Only when one contemplates the security offered by the protection of a broad, marshy valley and by that of the sea, can the rôle of geography in the Dobrudja campaign be fully appreciated. Throughout much of this campaign Rumanian troops were on the Teutons' flank, far in their rear and close to their vital line of communication. Yet von Mackensen pushed his offensive secure in the confidence that the marshy Danube interposed an impassable barrier to any Rumanian attack. Only one such attack was seriously attempted. A Rumanian force effected a temporary crossing at one point where a tongue of dry land projected through the marsh to the river's edge. Unable to maintain itself with such precarious connections with the northern bank, it soon withdrew under pressure. On the Black Sea side the Russians were in control. But landing from boats in the face of a determined enemy is a hazardous operation, while supplying an invading army from the sea is almost equally difficult. Von Mackensen's flanks were in fact effectively covered by two great natural features.

While the campaign in Dobrudja was being pushed to a successful issue, von Falkenhayn was assaulting the passes of the Transylvanian Alps in an attempt to break through to the Rumanian plain. Week after week his heavy artillery thundered its demands at the mountain gateways with but slight success. The Rumanian retreat was stayed where favorable physical conditions gave excellent opportunity for an effective defense. Massed in the narrow passes, Rumanian men and guns held the would-be invaders in check.

It will be seen from the map of Rumania that von Falkenhayn might make his main attack in any one of three directions. A successful advance through the northern passes would cut the main railroad in the Sereth valley connecting Russia with her new ally, isolate all of Rumania and the Rumanian army, and probably ensure their eventual surrender. For such a campaign the Teutons enjoyed some advantages over the Rumanians. Both possessed good lateral supply lines in the shape of railways following

FIG. 3.

FIG. 4.

FIG. 3—Part of the great Cernavoda Bridge over the Danube and its marshy floodplain. (Photo copyright by Underwood & Underwood.)

FIG. 4—Watergap of a tributary to the Olt River entering the lowland between the main range of the Transylvanian Alps and the minor parallel ridges to the south. (Photo by E. de Martonne.)

close along the mountain base, but the Hungarian railway lies closer to the mountain passes than does the Rumanian line. Again, as already pointed out, the northern passes all lie east of the main divide, offering some advantage to Hungarian troops moving down hill into Rumanian territory. It appears that the Teutonic armies made violent attempts to break through one or more of these passes, but without success. Attacks at Oituz Pass seem to have been especially severe, and fear of a possible advance at this point caused the Rumanians at Gyimes Pass to withdraw some miles to avoid being cut off in case this occurred. But the retreat was only local and for strategic reasons. Whatever the other advantages favoring the Teutons, the advantage which always lies with the defensive in a difficult terrain could not be overcome.

Von Falkenhayn next concentrated large forces against the central passes. An advance over the Predeal and Törzburg cols would bring the invader direct to Bukharest and cut Rumania in half. The returns for a successful campaign by this route would not be nearly so great as in the former case, but would nevertheless be enormous. Again both sides possessed the all-important lateral railway line along the mountain base; and again the line on the Hungarian side lay closest to the passes. But again the power of the defensive in mountainous country could not be broken. Several weeks of violent assaults pushed the Rumanians back from the main col of the Törzburg Pass to a secondary position, where they held firm. At Predeal the attacks seem to have been even less successful. By the middle of November von Falkenhayn's armies had been vainly hurling themselves against the eastern and central passes for a period of six weeks. The Teuton commander was then perforce compelled to content himself with the third possibility.

The western passes offered promise of a still smaller reward, but greater certainty of at least some success. Even if these passes were forced, only a small part of the Rumanian army could be cut off and destroyed. The main force would retire on Bukharest in good order. But in favor of an attack was the highly important fact that the lateral railway at the base of the mountains on the Rumanian side did not extend to the western part of the mountains, whereas the Hungarian lateral railway did so extend. Evidently the Teutons could use their railway to mass men and munitions at the Red Tower and Vulcan Passes in overwhelming quantity, to meet which concentration the Rumanians would find themselves quite helpless. If any pass could be forced by the Teuton armies, it must be one of these two. Vulcan Pass would perhaps offer the best opportunity, since the Hungarian railway sent a branch line within a few miles of it, whereas the Rumanians had to depend on a single wagon road for a number of miles to the south. The existence of a trail across the mountains west of the Jiu gorge offered a further advantage, since by means of it a flanking force might cross the old pass on the summit and take the defenders of the gorge in the rear.

Vulcan Pass was in fact chosen for the supreme attempt. The fighting here was very severe. After being pushed southward for several miles the Rumanians assumed the offensive and administered a severe check to the invader. Reports place the Teuton loss in this engagement as 1,500 killed and a larger number taken prisoner, while their defeated armies were driven back toward the north. But shortly after the middle of November the desired concentration of guns and shell was effected, and the Teutonic offensive renewed. Unable to match the enemy's superiority in artillery fire, the Rumanians gave ground, slowly at first, then more rapidly. When pressed out of the main pass, they made a stand on the first of the secondary ridges. Defeated here, they took up their position again on the next parallel ridge. But all in vain. The stop-gap to the pass was finally pushed aside, and the Teuton flood poured into the Rumanian plain.

Immediately the entire western end of the Transylvanian Alps barrier and the western end of the Danube barrier were outflanked. With the Teutons on the open plain in their rear, there was nothing for the defenders of these natural fortifications to do except escape as best they could to the east before every avenue was closed by the advancing enemy. As it was, some 8,000 Rumanian troops were completely cut off, in extreme western Wallachia, and later compelled to surrender.

About this time it became increasingly apparent that there was a serious and unexpected shortage of munitions in the Rumanian army. The sudden collapse of the defense at Vulcan Pass and the swift, if orderly, retreat of the Rumanians throughout the following weeks could not reasonably be explained on the basis of a munition shortage due to normal difficulties of supply resulting from poor supply lines alone. In a manner the retreat resembled the great Russian retreat of a year before; but whereas the Russians turned and gave battle behind every natural defensive barrier, the Rumanians scarcely halted for engagements of any real consequence.

The solution of this mystery is probably to be found in events disclosed by the Russian revolution. Russia was, for reasons of geographical position, the power upon which Rumania necessarily depended for aid. The Russian army was willing and loyal, but the Russian government was honeycombed with spies and traitors. Trainloads of shell consigned to the army were deflected to Vladivostok and other remote points by pro-German officials high in authority. Much-needed supplies accumulated at remote depots in enormous quantities, under orders designed to render the Russian army and her ally helpless before the German assault. The great Russian retreat and the crushing of Rumania must be charged, not to the brilliant military genius of a von Hindenburg, a von Mackensen, or a von Falkenhayn, but to the treacherous pro-German government which worked untiringly to reduce its heroic armies to a state of defenselessness. It is indeed a poor general who cannot defeat an enemy previously disarmed by some one else.

Had the Rumanians been properly supplied with shell the position of the Teuton army, debouching from a single, narrow pass and dependent on a single thin line of communication, would have been perilous in the extreme. As it was, the Rumanians were unable to profit by their opportunity, and fell back to the first effective line of defense, the Olt River, a fairly broad stream which issues from Transylvania through the Red Tower Pass and flows south across the Wallachian plain to the Danube. Unfortunately, the railroad which parallels this defensive barrier lies west of the river, and would thus give a lateral supply line to the Teuton pursuers, while the Rumanians would have no equivalent advantage. This alone was enough to render the line of the Olt of doubtful value. Aside from this consideration, it was questionable how long the Rumanian forces could hold the line under heavy Teuton fire when they themselves were unable to reply in kind. The issue was promptly settled, however, when von Mackensen, profiting by the Rumanian shortage of munitions, effected a passage of the Danube under cover of superior artillery fire at Zimnica, 30 miles east of the lower Olt. This manœuver completely outflanked the whole line of the Olt, and the Rumanian army fell back toward the east.

The Wallachian plain is in large part an alluvial slope underlain by sands and gravels deposited by streams issuing from the Transylvanian Alps, and is traversed by the extensions of these rivers, roughly parallel to the Olt but swinging more toward the east in their lower courses. As the Rumanian armies withdrew from the line of the Olt they fought brief delaying actions along one and another of the parallel streams. Thus we hear of them deployed along the Niaslov River, and later find them fighting a vigorous action along parts of the Arges. This latter river was expected by many to form the defensive screen for the capital, Bukharest. It is, however, poorly adapted to such a purpose. A railroad parallels it on the side next the city, which is as it should be; but the stream is not large, it lies too close to the city in its lower course, and its direction, strongly southeast, facilitated the outflanking of the defenders by an enemy force advancing eastward after capturing Pitesti and crossing the stream near its headwaters. None of the parallel rivers is supplied with broad belts of marsh, which alone render streams of moderate size really formidable military barriers.

After abandoning Bukharest the Rumanian forces retired northeastward, constantly swinging around more and more to the north as required by the shape of the country between the parallel bends of the Transylvanian Alps on the northwest and the Danube on the southeast. To accomplish this the Rumanian line, now strengthened by a large force of Russians, must pivot on its right wing, marking time there until the left wing, down near the Danube, could swing through a great arc and reach its appointed position. This was a difficult manœuver, made possible by the fact that the country increases in ruggedness toward the pivoting point. The

Rumanian right wing held the Teutons at bay in the mountains, while the left retired swiftly across the smooth plain.

During this part of the retreat we hear of a brief delaying action along the course of the Jalomitza River, and of a longer one at the Buzeu River. The Jalomitza is paralleled on its northern side by a railway which would afford the defenders a good lateral supply line, and the river with its more or less marshy flood plain is a protective screen of some value. It would appear that this line was outflanked, however, when the Teutons crossed the small headwaters near Ploesti, captured that town, and pushed on toward the town of Buzeu. One military critic based his discussions for some days on the thesis that the main defensive line to which the Rumanians were withdrawing was the line of the Buzeu River. Geographic conditions are distinctly against this thesis. The river is of fair size, but its course would permit a dangerous outflanking move toward the east where the course of the stream bends far to the north. The barrier is not sufficiently formidable to justify an attempt to hold its southwestern sector after other troops had reached its northeastern portion, 30 to 40 miles in the rear of the first position. A former course of the river, leading more directly eastward to the Danube and now occupied by marshes and lakes, might make a better line so far as direction is concerned; but it is not a barrier of serious proportions. Another reason why the Rumanians could not stand on the Buzeu line is found in the position of the railway, which parallels the stream on the southern side, thus affording a lateral line of communication for the enemy. With such an advantage the Teutons could quickly distribute men and artillery to any chosen point on the line and pierce it; while the defenders, lacking lateral communications, could offer but feeble resistance. The same objection applies to the so-called Sereth-Trotus line, selected by the same critic as the main defensive position after the Buzeu line had been passed. Both on the middle Sereth and the Trotus the railway is on the wrong side of the river. It would seem as though the railroads had been placed with reference to a foe expected from the northeast rather than from the west.

After a sharp contest on the Ramnic River the Russo-Rumanian forces took up their final stand behind the line of the lower Sereth and Putna Rivers. Inasmuch as some critics were convinced that no attempt would be made to hold the Putna line, and since furthermore the Teutonic pursuit was in fact brought to a complete check along this line in spite of desperate fighting, it will be worth while to examine the physiographic characteristics of the Putna and Sereth valleys with some care.

The Putna River rises near the great bend of the Transylvanian Alps and flows in general southeastward across the plain to join the Sereth between the towns of Focsani and Galatz. Before leaving the mountains two main headwater branches of the stream flow toward each other along the pronounced lowland already described as extending parallel to the main

crest, and unite to form a single river which has cut a transverse gorge through the first and most prominent of the secondary parallel ridges. In this region the Rumanians have utilized the secondary ridge, which rises 1,500 feet above the adjacent valley, as their natural defense.

After leaving the foothills, the Putna, still a stream of but moderate size, has a marshy floodplain from one-third of a mile to more than a mile in breadth. In the vicinity of Focsani the marshes widen out to a breadth of several miles, but just below there begins a stretch of dry land which continues to Fundeni, and which would facilitate a crossing by hostile troops. Fortunately, it is just here that the Sereth flows parallel and close to the Putna for some distance, reinforcing the latter by a really formidable obstacle. At Fundeni, however, there is neither marsh nor a double river barrier. Of all points on the Sereth-Putna line Fundeni appears to offer the best opportunity for an enemy crossing. The town lies on the north bank of the Sereth within a meander loop which projects southward. This would expose the town to a converging fire from three sides, and thus still further facilitate a crossing by hostile forces. It is true that there are some points favorable to the defense. The river at this point is nearly a quarter of a mile broad and too deep to ford. A number of old oxbow lakes on its southern side afford some additional protection. The great marshes of the lower Sereth begin close to the downstream side of the meander, rendering it difficult for an enemy to develop the full force of a converging attack. But since the marshes just referred to continue in a broad belt to the Danube at Galatz, and the Danube from Galatz to the Black Sea is an impassable barrier of distributary river channels on a marshy delta dotted with lakes both large and small, it must still appear that the Fundeni sector is from its physiographic character the point where enemy attacks should most confidently be expected.

We have seen that the Sereth-Putna line is a defensive barrier of some degree of formidableness. An examination of the railways in this region shows that the line is supplied with lateral communications well adapted to deliver shells, supplies, and reinforcements to the defenders, wherever need should arise. The Sereth is paralleled by a railway from Galatz to the mouth of the Putna. The main central railway of Moldavia, over which Russian reinforcements must largely come, leads up to the center of the Putna defensive line, while a lateral branch connects this main railway with the one paralleling the lower Sereth. The extension of the Putna line along the secondary ridge and thence northwest past Oituz Pass and Gyimes Pass is paralleled by the Trotus valley railway. All these railways, it will be noted, are on the north of the defensive barrier, and so protected by it from hostile attack. This alone would be sufficient to explain why the Sereth-Putna line is superior to the Sereth-Trotus farther north, or the Buzeu line farther south.

The Teutonic armies arrived before the Sereth-Putna line during the

first week of January, 1917. They first tried to force the marshes of the Putna River north of Focsani, at the end of the railway and highroad along which one of their main columns was advancing. At one time, under cover of a fog, some Teuton troops gained the northern bank of the river but were quickly driven back. A second attempt was made near Galatz, in the hope of turning the left flank of the defensive line. After capturing Braila, a Teuton column struggled painfully along the railway embankment which crosses the marshes to Vadeni and the bridge over the lower Sereth. Many days of heavy fighting resulted in the capture of Vadeni, but it proved impossible to manœuver to advantage in this region of marshes. The crossing of the river could not be effected, and Vadeni was soon recaptured by a Russian advance guard.

By this time troops and supplies had been assembled for a violent assault on that part of the line offering the best chance of a successful crossing. Advancing over the dry ground toward Fundeni, the Teutons launched an offensive at the town shortly after the middle of January. The importance of this attack may be gauged from the fact that the best Prussian troops in the Teuton armies were thrown into the fighting. Day after day the struggle dragged on, and still the river barrier barred the way to Teuton ambition. February found the baffled armies of the Central Powers still fighting to cross the barrier, and the world began to realize that the marshy valley of the Sereth and Putna constituted a military obstacle of commanding importance.

While suffering defeat in every attempt to turn the left wing or to break through the center of the Sereth-Putna line, the Teutons were not idle up in the mountains, where a successful advance would turn the right of the line and flank the defenders out of the entire position. For more than a month a colossal effort was made to break through the Oituz Pass. To understand what success in this endeavor would mean, one must carefully note the pattern of the valleys in the vicinity of the pass. In the upper Trotus valley four branch ravines, converging upon the town of Onesti, have more or less practicable passes near their heads. Thus the upper Trotus itself heads in Gyimes Pass and carries a railroad and highroad; the upper Uz heads in an unimportant pass through which there runs a trail; the upper Oituz forms the Oituz Pass, which has a good wagon road; and the upper Casinul starts at a minor pass provided with a trail.

Now it is clear that if the Teutons succeeded in forcing any one of these passes and reached Onesti, the trunk supply line would be cut and the forces defending the other passes would be trapped. But this is not all; for once the four passes were thrown open by such a successful manœuver, and a Teuton army concentrated in the Trotus valley, backed by three good supply lines (a railroad and two wagon roads) through the Gyimes and Oituz Passes, nothing could check a Teuton advance down valley to its junction with the Sereth. This would take in the rear all the northwestern

extension of the Putna line and would cut the central Moldavian railway, the vital artery upon which all the rest of the Putna line depends. The moment this main railway was reached, a retreat to the northeast, behind the middle Sereth River, would be forced. In other words, a success in one of the passes at the right of the Sereth-Putna line would outflank practically the entire position.

No wonder the fighting at Oituz Pass occupied the attention of the world for a number of weeks! Four Teuton columns entered the heads of the four branch valleys and all fought desperately to reach Onesti. The advance through Oituz Pass seemed to promise the best advantage to the Teuton offensive, and would reach the Trotus valley railway only a few miles from the crest of the range. But the power of the defensive, blocking the narrow valleys, was too great. The column in the Casinul valley got within ten miles of its objective when it was thrown back. The other columns were even less successful. A furious attack on the secondary ridge farther southeast fared no better. Every attempt to reach the Trotus valley railway failed. The difficult mountain topography prevented the turning of the Sereth-Putna line on the right just as effectively as the marshes near Galatz prevented the turning of the left.

The Rumanian campaign, beginning on the defensive line of the Transylvanian Alps and Danube marshes, ended on the defensive line of the northern Transylvanian Alps and Sereth-Putna marshes.

A DECADE OF THE SALTON SEA

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Extending from the lower course of the Colorado River in a north-northwesterly direction to San Gorgonio Pass, the longitudinal depression between the San Bernardino and the San Jacinto Ranges through which the Southern Pacific Railway runs to the coastal lowland of Southern California and its metropolis Los Angeles, lies a wedge-shaped basin, 185 miles long, generally known as the Cahuilla Basin. Its apex lies to the northwest; on its two long sides it is bounded by mountain ranges: on the northeast by the San Bernardino Range, the Chuckawalla Mountains, and the Chocolate Range, which separate it from the Mohave Desert; on the southwest, by the San Jacinto Range, the Santa Rosa Mountains, Superstition Mountain, and the Cocopah Mountains, the last of which separate it from the Pattie Basin, a similar depression, bounded on the west by the Peninsula Range of Lower California. In longitudinal profile the Cahuilla Basin is spoon-shaped, with the bowl to the southeast and the stem to the northwest. The rim of the bowl is formed by the delta of the Colorado River, from which the floor slopes down to 265 feet below sea level in the part nearest the stem. It is here that the Salton Sea lies.[1]

Variable quantities of flood waters have at intervals of a few years escaped from the main or effluent channels of the delta of the Colorado River and flowed down the slopes of the basin, sometimes collecting as a series of pools or lagoons at the bottom and at other times making the body of water which has been in recent times known as the Salton Sea. If the inflow continued until it overflowed the lower part of the delta which separates the basin from the Gulf of California, an area of about 2,200 square miles would be covered and the shores of the lake would be something like twenty feet above the datum taken as sea level by the U. S. Geological Survey, the bottom of the basin lying 274 feet below.

The general consensus of the physical and biological evidence is to the effect that three or four centuries have elapsed since water rose in the basin to the highest level. The number of times the lake has reached the

[1] Cf. Reconnaissance Map of the Salton Sink, California, 1:500,000, U. S. Geol. Survey, Washington, 1906.
Relief Map of the Lower Colorado River, Showing Irrigable Lands in the United States and Mexico, January, 1905 [photograph, 1:1,250,000, of a relief model]. Accompanies "The Salton Sea" by F. H. Newell, *Ann. Rept. Smithsonian Inst. for Year Ending June 30, 1907*, pp. 331-345.
Map of the Desert of the Colorado, compiled by G. Sykes [1:800,000], Pl. 2, "The Salton Sea: A Study of the Geography, the Geology, the Floristics, and the Ecology of a Desert Basin," by D. T. MacDougal and collaborators, *Carnegie Inst. Publ. No. 198*, Washington, 1914.
Map of the Delta of the Colorado River, Including the Salton and Pattie Basins, compiled and drawn by Godfrey Sykes [1:1,500,000]. Accompanies "The Desert Basins of the Colorado Delta" by D. T. MacDougal, *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, pp. 705-729.

maximum is not clear; some writers are disposed to favor the inference that it stood so high but once in its history and then perhaps for less than a century. Loss by evaporation in this region is such that of a possible total of 116 inches, a layer of 40 to 60 inches passes off in vapor every year. If the lake were filled to its high level by a single flood, and thereafter received nothing but the drainage of the surrounding slopes, nearly a

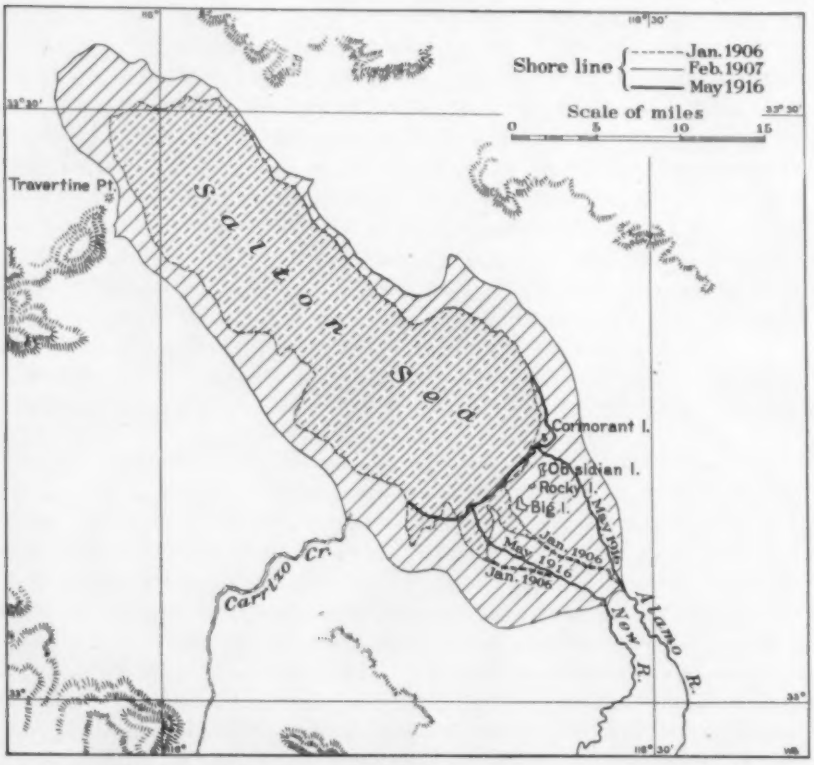

FIG. 1—Sketch-map of the Salton Sea showing levels of January, 1906, and February, 1907, and position of delta and lower course of the New and Alamo Rivers in May, 1916. Scale 1:650,000. (January, 1906, shore line based on "Reconnaissance Map of the Salton Sink, California," 1:500,000, U. S. Geological Survey, Washington, 1906.)

century would elapse before it dried up to leave the white saline beds on its bottom.

The earliest notice of floods escaping into the basin is of 1840, followed by others of 1842, 1852, 1859, 1862, and 1867, and but little is known of the body of water accumulating in the basin in each case. A notable inundation occurred in 1891, when the water came near the line of the Southern Pacific Railway and a representative of a newspaper followed a stream of water from the main channel of the Colorado River down into

the lake itself. These occurrences within recent time are probably continuous with the earlier history of the basin.

When a lake has once been made, its recession is a halting one, with many partial returns toward the maximum level and perhaps a few actual refillings. However this may have occurred, the heavy deposit, formed on the rocks which were a few feet below the surface at the high level, yields irrefutable evidence that either in one period or in several periods the lake stood full or nearly so for a time sufficient for the organic formation of a travertine layer one to three feet in thickness. The halting and irregular recession of the lake is finely recorded in the terraces which are formed when the water stands a few months at any given level. The upper two hundred feet of a gravelly slope near the railroad station of Salton shows 83 of these shelves or benches of assorted material, as has been determined by Professor Ellsworth Huntington and the writer. The terraces remain as one apparent series, however, and no means has yet been found for distinguishing between those of an older lake on the higher slopes and more recent benches near the bottom resulting from the action of a smaller lake.

The conclusions as to the oscillation and refilling of the lake were therefore based simply on allowable assumptions until early in 1915, when a discovery was made which placed the matter on a basis of record of some historical value. In the tufa coating on an outlying mass of fragmented granite projecting into the southwestern side of the Cahuilla Basin a number of carved designs of Indian origin were found by us in 1906, and had probably been seen by earlier visitors to the place. The formation is designated as "Travertine Rock" and "Travertine Point" in our various publications. The crest rises a few feet above the maximum level of the lake and would have showed as a small rocky islet. A few feet below high-water mark the deposit of tufa reaches a thickness of several feet. Below this the tufa or travertine is not so heavy, thinning down to a few inches near the base of the granite mass. Now this tufa is a lime formation which is made only in fresh or slightly brackish water, and as it seemed highly probable that the occurrence of the carvings might yield some evidence on the history of the lake, a special visit was made to this place in company with Mr. Godfrey Sykes in March, 1915, for the purpose of making a more careful examination of the formation. The half-light of a cloudy day was favorable to the discovery of a large number of carved figures. Some of these showed as deep furrowings visible at a hundred yards, and others were so faint as to be barely discernible (see Fig. 5). Cuttings made through some of the lines showed that none of the carvings had been made in the granite but were chipped in the travertine deposited on it. Next it became clear, upon examination of polished slices of the rock, that some of the cuttings had been subsequently coated with additional layers of travertine. This would indicate that after aboriginal man came into the region and acquired the art and habit of making such figures, he frequented

FIG. 2—Salton Sea: view across strand of 1915 and across strip of water to Cormorant Island. The plants of pickleweed in the foreground mark the lower limits of the strand of 1914. Photographed May, 1916.

FIG. 3—Terraces formed by the lake in the winter of 1915-16. Strand of 1915, devoid of vegetation, on the left; water receding from the terrace on the right. May, 1916.

this bold foreland and cut his symbols of lightning, of storms, and of the serpent; then the lake rose and coated them over. With its recession a few years or a century later, the place making its natural appeal to the primitive mind as suitable for records, other carvings were added from time to time. Much importance must have been attached to recognizable figures uncovered by the lake. It is notable, however, that none of the figures were made in the present surface of the travertine, a condition paralleled by series of carvings in many places in Arizona. Whatever may have been the reasons for the discontinuance of the making of figures on any ordinary "pictured rocks" it is clear that a full lake came after all made on Travertine Point. After these undated records of the aborigines came the explorer, and the hope still survives that the records of the Spanish expeditions of the sixteenth and seventeenth centuries may yet yield some notes as to this region, in addition to Rocque's map of the eighteenth century.[2]

The influx of a body of fresh water into a saline basin which in ordinary times was a desert of a very pronounced type might be expected to be accompanied by serious disturbances of the physical conditions, which would be reflected in the behavior and geographical relations of the plants and animals of the region. This may be best understood when the topographical and meteorological conditions are recalled. The basin is subject to a mixed type of climate. It lies far enough inland for overheating to result in a continental type of climate, particularly with respect to the rainfall. Its great bowl, however, lies immediately in the lee of a great mountain range which rises abruptly from its southwestern side, with the result that fringes of mountain storms reach out over part of its area at times, while the topographical conditions favor the development of the intense and localized precipitation known as cloudbursts.

The annual average rainfall from data covering thirty-six years is 2.74 inches, and the character of the precipitation phenomena suggests a high degree of aridity. The maximum amount of rain received in one year was 7.10 inches (1906) and the lowest, a "trace" (less than .01 inches), in 1904, giving a variation as 1 to 1,000, a proportion occurring in deserts of a pronounced degree of aridity only. Another method of characterizing deserts according to their aridity is to give the ratio of possible evaporation from a free-water surface to the annual amount of precipitation. In the Cahuilla Basin about 116 inches of water would evaporate during a year from the surface of a small vessel on the ground in the open; this is fifteen times the amount which has fallen in any one year; forty-three times the average, and many thousands of times the minimum. The region is in fact a desert of the most advanced type, in which desiccation has progressed to such an extent as to reduce the native flora to less than 140 species of seed plants.

The setting and the constructive arrangement for an experiment which

[2] See Pl. 2, *Carnegie Inst. Publ. No. 193* (title cited in footnote 1).

would test the effects of a body of fresh water on the native organisms of such a desert were made when a company, organized for the purpose of irrigating an area in the basin, began "the task of connecting and clearing the various channels which formed the natural waterway between the river and the basin; and by the middle of 1901 water was flowing upon the irrigable lands of what has since become known as the Imperial Valley. It had been deemed advisable by the promoters of the scheme to take the water from the river in United States territory, and so the upper section of the canal was cut almost parallel to the river for several miles and with a very low gradient. This circumstance, together with the general unsuitability of the site selected for the head works, caused considerable trouble for two or three years, as more and more water was required to fulfill the demands of the growing communities in the desert; and so various openings were made between the river and the canal in order to furnish a more adequate supply.

"Then, in the winter of 1904-05, one of the infrequent winter floods in the Colorado, coincident with a tremendous rush of storm waters from the Gila, found before itself the unprotected head and comparatively steep downward grade of the canal, and at once began to cut and enlarge the channel. The ordinary summer flood of 1905 also poured its water through the opening, and it was soon realized that the outpour had got beyond control.

"Practically the whole of the Colorado was now flowing into the Salton Basin, and another flood in the following November (1905) made the task of closing the breach seem almost hopeless, although the most strenuous efforts were being made by the engineers; and it was not until February, 1907, that the Colorado was finally returned into its former channel."[2]

The lake formed had a depth of from 80 to 85 feet, and the total area of this latest Salton Sea was estimated at from 450 to 500 square miles (see map, Fig. 1).

Field plans of the Desert Laboratory staff for the study of the surface phenomena of arid regions were put into final form in 1906, and the Salton Sea offered an unexampled opportunity for the measurement of its recession and the observation of the accompanying successions of vegetation from aquatic to desert conditions.

The actual number of species of plants native to the Cahuilla Basin comprises less than 140 ferns and seed plants, of which five, or three per cent of the whole list, are endemic and the greater number are suitable for existence in saline soils. The influx of the flood waters brought the seeds of a large number of species of land and shore plants from along several hundred miles of the Colorado River, and these, together with the seeds which had been floated from the dry slopes of the basin, were cast on

[2] D. T. MacDougal: The Salton Sea, *Amer. Journ. of Science*, 4th Series, Vol. 39, 1915, pp. 231-250; quotation on p. 235.

FIG. 4.

FIG. 5.

FIG. 4—Salton Sea: dense vegetation on beaches of Obsidian Island, strands of 1907 to 1912.
FIG. 5—Figures in the travertine on Travertine Point.

FIG. 6.

FIG. 7.

FIG. 6—Delta of the New River. Effluent leading off to the right one-fourth of a mile to the margin of the lake. May, 1916.

FIG. 7—Channel of the Alamo River above recent high level of the lake, carrying average flow into the lake. May, 1916.

the moist shores of the lake. The water remained practically stationary at its highest level but a few hours, and then the loss by seepage and by evaporation was so great that the margin receded several feet per day on the gentler slopes, so that in some places around the southeastern end of the lake a strip a mile or more in width was laid bare in a year. This emersed strip of 1907, having been washed by the water in its freshest stage, was sown with the seeds, including the greatest number of species possible under the circumstances, with the result that in the cooler season at the end of this year dense ranks and belts of vegetation occupied the shores much as if the lake were of fresh or brackish water, and these zonal formations included the greatest number of species yet seen about it. In the succeeding years the water was a more concentrated solution of the contained salts, the supply of seeds from the river was cut off, and consequently the beaches, now increasingly salty, were less richly sown each year, with the result that by the spring of 1916 only a few species appeared on the shores recently abandoned by the lake. This fact was taken to mark the end of the first stage of the recession of the lake and concluded a period in which the muddy shores were at first occupied by ordinary land species, some of which failed to appear in the succeeding years, until at the present time only pickleweed *(Spirostachys occidentalis)*, seablite *(Suaeda torreyana)*, sea-purslane *(Sesuvium sessile)*, salt bush *(Atriplex canescens)*, and beach-heliotrope *(Heliotropium curassavicum)*—species common to saline shores and salty areas—come on the beaches. The newly emersed strips were occupied during the first year in the earlier stages of the lake, but now only a few plants come in until the soil has been bare for a year. It is probable that one of the factors in the matter is that of the oxygen in the soil. The ground now being laid bare is closely packed and saturated, and the pioneer species cannot grow in it until some aëration has taken place (Fig. 4).

The definite close of the cycle in pioneer occupation has also called attention to another phase of the vegetative phenomena, that of the successions or changes on the emersed beaches. It is easily to be understood that the plants which came in on the moist belt of land from which the lake receded in 1907 could not maintain themselves indefinitely in that place. The original supply of moisture not being replenished in any adequate manner, the fresh-water pioneers slowly succumbed to increasing desiccation, which in turn offered favorable conditions for desert species. The succession or changes from the condition of close-ranked moisture-requiring species to that of the open formations took place so rapidly that the nearly static condition of the latter might be reached in a half-dozen years or even less. In fact many square miles of territory submerged in 1906 and 1907 have now returned to the desert conditions previously prevalent (Fig. 3).

The conditions of salinity in the water of the lake have likewise made

a similar succession, but for the most part of organisms not visible to the eye. The water at the maximum level of the lake contained about one-third of one per cent of dissolved matter, and its use as drinking water was a matter of friendly competition among the members of the exploring party who circumnavigated the lake at this time and the results were given in our publication on this subject as follows[4]: "The water at this time [February, 1907] contained about 0.25 per cent of dissolved salts, which is near the limit of potability. This was denoted by the fact that it could be used by some members of the party, but not by others."

Potability is in itself a very uncertain feature of waters in desert regions, as has been most adequately set forth by Phillips as follows[5]:

> "Drinking water" is a *façon de parler* in the desert. Threepennyweight of salt to the quart [about .5 per cent] is enough, as the reader will find if he tries, to give it a strong briny flavor. Such water, however, is freely drunk in the Sahara. Horses, camels, and donkeys even thrive on water containing nearly half an ounce of salt to the quart. It varies very much in different neighborhoods, but is always distinctly brackish and generally impregnated besides with potash, magnesia, sulphuric acid, and other delicacies, to such an extent that the old custom of poisoning the wells always struck me as a very superfluous one.
>
> All things, however, adapt themselves to it. Water that will appease the thirst of an Arab would only aggravate that of a European.

The facts and the cited comment are given place, since a reviewer has made the statement that no reference was made to the potability of the water in the Salton volume.[6]

The results of the annual analyses incorporated in the table on page 468 were carefully scrutinized every year for the purpose of detecting changes in the composition of the water which might be correlated with the behavior of the plants affected by the water. During the first year of the recession of the lake the chief mineral constituents increased so that the amount present was about 19 to nearly 21 per cent greater in 1908 than in 1907. This increase was shared by the calcium. In the following year, while the sodium increased 19.4 per cent and the potassium 16.5 per cent, calcium increased but 7 per cent and in the following year but slightly more. Coincidently the missing calcium was found as a lime deposit on the branches of submerged shrubs, stones, and other objects. The amount of calcium in the solution had by no means reached the saturation point. and other causes must be brought in to account for the deposition. The above applies also to some extent to the course of concentration of the magnesium. The only available inference is that the lime and magnesia were being brought down by the action of a plexus of algae and bacteria. The inferred presence of these organisms would carry with it the implication that the formation of the lake would be followed by their multiplica-

[4] *Carnegie Inst. Publ. No. 103*, p. 117.

[5] L. March Phillips: In the Desert and the Hinterland of Algiers, London, 1909, pp. 184 and 185.

[6] See Mark Jefferson, *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, p. 885, who says in a review of "The Salton Sea": "We do not learn whether the Salton Sea was, or is now, drinkable."

TEN COMPLETE ANALYSES OF THE SALTON SEA WATER

	PARTS PER 100,000									
	JUNE 3, 1907	MAY 25, 1908	JUNE 8, 1909	MAY 22, 1910	JUNE 3, 1911	JUNE 10, 1912	JUNE 18, 1913	JUNE 12, 1914	JUNE 8, 1915	JUNE 10, 1916
Total solids (dried at 110° C.) plus water of occlusion and hydration	364.8	437.20	519.40	603.80	718.00	846.55	1002.56	1179.6	1377.4	1647.2
Water of occlusion and hydration	....	....	17.50	22.56	20.84	23.9	32.6	36.2	42.2	47.5
Sodium, Na	111.05	134.26	160.33	189.28	227.81	276.71	323.08	381.47	441.6	528.9
Potassium, K	2.30	2.78	3.24	3.53	3.81	3.81	3.45	4.01	5.2	5.71
Lithium, Li	trace	0.013	0.017	0.021	0.025	....	....	....	....	....
Calcium, Ca	9.95	11.87	12.70	13.67	15.62	17.28	19.75	22.22	25.27	29.85
Magnesium, Mg	6.43	7.63	8.96	9.84	11.68	13.62	16.22	19.03	22.63	27.17
Aluminum, Al	0.030	0.035	0.062	0.040	0.089	0.100	0.125	0.140	0.032	0.034
Iron, Fe	0.005	0.006	0.010	0.008	0.036	0.042	0.038	0.012	0.020	0.060
Silicate radicle, SiO_4	1.41	1.43	1.59	1.55	1.83	1.79	2.18	2.42	1.55	1.21
Manganese, Mn	....	....	....	....	....	....	....	....	....	....
Lead, Pb	....	....	....	....	....	....	....	....	....	....
Copper, Cu	....	....	trace	trace	trace	....	....	trace	....	....
Chlorine, Cl	169.75	204.05	240.90	280.93	339.42	395.44	473.89	559.66	650.95	787.64
Bromine, Br	....	....	....	....	....	....	....	....	....	....
Iodine, I	....	....	....	....	....	....	....	....	....	....
Sulphate radicle, SO_4	47.60	56.74	65.87	76.36	91.67	106.83	124.65	148.10	174.47	207.89
Carbonate radicle, CO_3	6.58	7.66	7.34	6.38	5.78	12.09	11.28	10.96	11.92	11.40
Arsenate radicle, AsO_4	....	....	....	....	....	....	....	....	....	....
Phosphate radicle, PO_4	0.009	0.011	0.01	0.013	trace	trace	trace	....	....	doubtful
Nitrate radicle, NO_3	0.18	0.20	....	....	....	trace	....	....	....	....
Nitrite radicle, NO_2	....	....	0.0006	....	....	....	....	....	....	trace
Oxygen consumed	0.093	0.059	0.068	0.045	0.063	0.072	0.110	0.110	0.208	0.170
Borate radicle, BO_2	....	trace	trace	trace	trace	....	trace	trace	trace	trace

tion and development, which was such that the maximum formation of tufa or lime deposit was greatest in 1909 and 1910, during which period the amount thrown down was sufficient to account for about half of the expected increase in concentration of lime. In succeeding years this action was not so marked.

It is notable that the travertine deposit on the slopes of the basin is of a parallel nature. The heaviest deposit is a few feet below the maximum level of the lake and then thins down toward the bottom. The decrease in deposition does not coincide with a poverty of material and may therefore be reasonably ascribed to a modification of the activities of the organisms. Thus, while some calcium and magnesium is being lost from the solution, it now no longer comes down as coatings on objects in place, and it probably settles in the form of minute particles, although the almost ceaseless motion of the water prevents it from forming a definite and visible layer.

A somewhat similar fluctuation of the potassium in the water is as yet unaccounted for. Thus no increase of this element occurred in the year ending June, 1912, and an actual decrease followed.

Any discussion of the influence of the lake on the surrounding region would be incomplete without the mention of the fantastic popular notion that the climate hundreds of miles away was modified by its tempering action. The presence of the lake, of course, implies a blanket of vapor pressed shoreward by the prevailing winds, and it was obvious that the heightened humidity did exercise an effect on vegetation within a few hundred yards of the shore.

The most marked effect on the vegetation of areas not actually affected by the submergence was that resulting from the checked underflow from the mountain slopes on the southwestern shore of the lake. The water thus prevented from escaping to lower levels accumulated and was forced so near to the surface as to be available for plants, which showed a luxuriance much beyond that prevalent in the empty basin.

Somewhat sensational is the emergence, after the recession of the lake, of the mud volcanoes which lie on the northeastern slopes of the basin near some hills which have become islands. These vents were covered with water in 1907, and, although the course of sail boats and launches was laid over them, nothing was seen of them until late in 1915, when they began to boil up irregularly through the water when it came down to a depth of five or six feet, sometimes throwing a mass of mud several feet above the surface. Vents entirely uncovered resumed activity in boiling pools, with a notable emission of gases (Fig. 8).

Four volcanic hills lie on a north-south axis in the southeastern part of the basin. The summits of three of these remained above the level of the water in 1907, and the occupation of the beaches around these islands by vegetation has been described in detail elsewhere[7] (see also Fig. 4).

[7] *Carnegie Inst. Publ. No. 198*, p. 125 ff. and 168 ff.

FIG. 8—Salton Sea: mud volcanoes in the strand laid bare in 1915 through the recession of the lake. May, 1916.

Wind-borne seeds and floating seeds, root-stocks, and seedlings found lodgment on the moist strands, resulting in a series of successions not essentially different from that on the main shores of the lake. These three higher hills have now become joined to the mainland.

The smallest hill of the group, however, was so nearly covered by the floods that its summit was repeatedly washed by the slightly salty water in 1907, and it was therefore considered as sterilized of all of the seed plants. Its emersed portion, which was designated as Cormorant Island, offered an unusually interesting area upon which the occurrence of plants could be followed with some exactness. Two miles of water separated it from the nearest island, and in 1908, at which time the first two individual plants were found, six or seven miles of water separated it from the main shore. These two pioneers were "arrow-weed," *Pluchea sericea*, and *Baccharis glutinosa*. The census of the plant population of the island was taken again in 1912 and in May, 1916, the analysis of the population being as below:

REVEGETATION OF CORMORANT ISLAND

	Number of individuals		
Eleven Species	1908	1912	1916
Atriplex lentiformis	..	5	35
Baccharis glutinosa	1	2	..
Cryptanthe barbigera	..	..	1
Distichlis spicata	..	..	1
Erigeron canadensis	..	..	2
Heliotropium curassavicum	..	2	15
Lactuca asper	..	..	2
Pluchea sericea	1	2	4
Rumex berlandieri	..	..	1
Sesuvium sessile	..	2	5
Spirostachys occidentalis	..	20	404
Total— 2 species	2	..	..
Total— 6 species	..	33	..
Total—10 species	..	..	470

The total number of species now occupying the island is probably as great as when it was a desert hill. It is to be noted that 460 of the 470 individuals on the island are salt plants, and that one of the pioneers, *Baccharis*, has already been lost.

The general features of dissemination by which these species may have reached this island across the intervening expanse of water has already been discussed in full[8] and will not be described in detail here. *Baccharis*, *Erigeron*, *Lactuca*, and *Pluchea* have plumed seeds which are readily transported over intervals of a few miles by gales or gusts of wind. The seeds of *Atriplex* float, and, as germination may ensue in the water and as the plantlets may float about for some time and then take root upon stranding,

[8] *Carnegie Inst. Publ. No. 193*, p. 125 ff. and 168 ff.

it is evident that a strip of water a mile or two in width instead of being a barrier might even facilitate the travels of this plant. The seedlings of *Sesuvium* and *Spirostachys* may also float about for some time and take root when cast ashore, and *Rumex* might be carried about in the lake in the same manner. Very small seeds such as those of the *Heliotropium, Spirostachys,* and *Sesuvium* may be picked up and carried long distances by the winds.

The reoccupation of this island has been studied with perhaps greater care than that of any other area which has ever come under the observation of a naturalist. The dissemination of plants by the flotation of seedlings seems to be a hitherto undescribed mode of travel by plants. Although the most serious efforts were made to detect the transportation of seeds by birds after the manner upon which so much has been written by Darwin and others, no well-proved case was found. The inference was strongly to the effect that the burrlike fruits of *Cryptanthe* had been carried to Cormorant Island and also to other beaches by birds.

The great trough in which the Salton Sea lies has been partially filled by alluvium carried into it by the Colorado River, which has finally built a great dam separating the trough from the Gulf of California. Every inflow has carried its contribution of sand and silt, the greater portion of which would naturally be deposited in the southernmost part of the trough, with the result that the surface has been raised to form a dam separating a part of the trough from the Gulf of California as the present basin. The present filling of the lake was exceptionally effective in this way. The silt-laden waters of the Colorado which flowed into the basin in 1904-07 through the streamways designated as New River and Alamo River cut deep and wide channels in the alluvium and carried down below the recent water levels a mass of material amounting to about twice the total taken out in excavating the Panama Canal, or one-fourteenth of a cubic mile (Figs. 6 and 7). The silt-laden water of the Colorado River deposits about 6 per cent of its volume as dried soil, so that the total fill left by the present flood is estimated as amounting to about one-third of a cubic mile. Otherwise stated, the present Salton Sea will leave below its high level one-twelfth of its volume in soil. This material is of course unevenly distributed, and every inundation of the basin results in filling and altered surfaces. The change in contour is especially noticeable at the present time and is readily observable since the lake in 1916 stood nearly at the same level as in January, 1906. The low inclines into which arms of the lake extended a decade ago are now filled, and the channels of the two inflowing streams now follow into the receding lake on lines widely variant from those used in the formation of the lake (Fig. 1). It is obvious that all of the alluvial fill in the basin might be accounted for by the floods of the last few hundred years and that all of the main events in its history might have occurred within comparatively recent time.

Salton Sea reached an area of about 450 square miles in 1907. It has now shrunken by uneven and halting recessions to a depth of hardly more than 30 feet, or less than half the maximum, with an area of less than 300 square miles. The overflow and wastage of the vast irrigated district in the "Imperial Valley," as the southern end of the basin is designated, is such that at certain times subsidence ceases and an actual rise occurs, although each June has found the level a yard or more below that of the previous year. Conditions now prevalent, however, will soon bring the lake down to an area of about 200 square miles, where its evaporation losses and fillings will give it the character of an oscillating lake. Thus the ancient Blake Sea, followed by the ephemeral or intermittent Salton Sea, has now been succeeded by a lake the permanency of which will be coincident with our present system of agricultural practice.

OUR TRADE IN THE GREAT WAR*

By MARK JEFFERSON

The war has brought a great expansion of foreign trade to the United States, the total for the year 1916 being nearly double the average amount for the years 1911 to 1914. In millions of dollars, the amounts were as follows:

1911	*1912*	*1913*	*1914*	*1915*	*1916*
3624	4217	4277	3903	5334	7873
				(5067)	(5668)

The greater part of the increase of the last two years has been in exports:

Exports	2092	2399	2484	2114	3555	5481
					(3377)	(3946)
Imports	1532	1818	1793	1789	1779	2392
					(1690)	(1722)

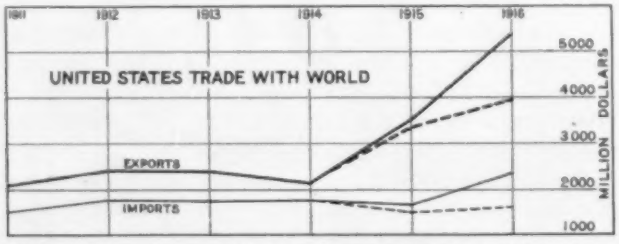

FIG. 1—Diagram showing the effect of the war on United States foreign trade. (The dotted parts of the curves in Figs. 1 and 2 indicate the values as corrected to eliminate the war inflation of prices; see the text.

And of the exports those to Europe have been most augmented:

Exports to Europe....	1293	1467	1500	1339	2573	3814
					(2444)	(2746)
Other	799	932	984	775	982	1667
					(933)	(1200)

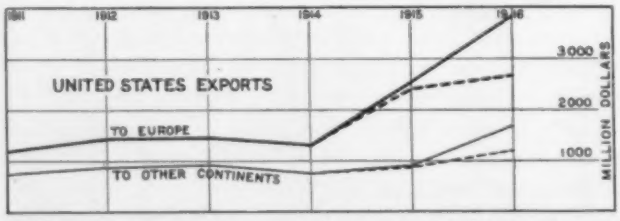

FIG. 2—Diagram showing the effect of the war on United States exports to Europe as compared with exports to other parts of the world.

But the prices of the years 1915 and 1916 have been unprecedentedly high. A part of the increase of business is therefore fictitious, being not an increase of goods but of money collected for them. From an examination

* The statements and terminology of this article apply to conditions prior to the entry of the United States into the war.—EDIT. NOTE.

of the exports to Europe, it appears that about one-half of the total for 1916 is made up of cotton, gunpowder, mineral oils, flour, brass bars and plates, horses, wheat, oats, corn, lard, hams and shoulders, bacon, and mules. These amounted to 1,773 million dollars of the total export to Europe of 3,814. Had they been reckoned at 1914 prices they would have been worth but 1,282 million dollars, or 72 per cent as much. Similarly the total exports to Europe in 1915 would have been worth 95 per cent as much at 1914 prices as at the prices actually charged. As a rough corrective to the effect of inflated prices in 1915 all figures for 1915 have been multiplied by 95 per cent and all those for 1916 by 72 per cent, with the result:

	1915	*1916*
Total foreign commerce of the United States	5067	5668

These and the other corrected values are indicated in parentheses in the tables above and as dotted lines in the diagrams. These new values and curves show that the inflation of prices contributed a good deal to the recent increase of trade, but it still remains true that there has been an unprecedented increase in our commerce, especially in our exports to Europe.

Of course it is obvious that this ought to be the case, for the great war is the only possible cause. It is striking that all the values fell sharply in 1914 and all the exports rose still more sharply in 1915 and again, but less strongly, in 1916. The retirement of German carriers from the oceans probably suffices quite of itself to explain the checked commerce in 1914. The decrease doubtless belongs to the last five months alone, but the financial disturbance at the outbreak of the war and doubts about payments and credits on shipments must also have had their influence.

It is of interest to examine our exports, both to Europe and to other continents. In the first place, without examining destination of goods it is significant that explosives and chemicals increased enormously, as the following (uncorrected) values show:

1911	*1912*	*1913*	*1914*	*1915*	*1916*	
14	14	15	22	245	844	million dollars
Metals, machines, and automobiles also—						
371	454	481	367	715	1594	" "
Foods again were immediately called for:						
		193	192	422	510	" "
There was immense increase in horses and mules:						
		5	9	119	91	" "
and also in rubber—						
13	14	14	12	24	34	" "

Plainly, our increased business was the exportation of war supplies to Europe. Note that explosives and horses and mules did not fall off in 1914, as did other materials, but contented themselves with very moderate increases. The urgency of the occasion diverted tonnage to these imme-

diate needs at once. Of course the supplies in most immediate demand went up strongly in price. Gunpowder was 33 cents a pound in 1914 and 83 cents in 1916. Much more powder must have been used in Europe these three years than in all the rest of the world. This consideration of the relation of the European demand to the world-demand must enter into the rise of prices, for they are affected very differently. Thus of oats were supplied 19 million dollars' worth in 1914, 59 million in 1915, and 53 million in 1916, at 54 cents, 56 cents, and 52 cents a bushel, oats being thus actually 4 per cent cheaper in 1916 than two years before!

The main items included above as "food" are corn, oatmeal, oats, rice, meats and dairy products, sugar, and potatoes. They are the food substances that have been exported in greatly increased quantities: corn and oats, amounting together to 28, 31, 97, and 100 million dollars in 1913, 1914, 1915, 1916; meats, amounting to 157, 137, 259, and 279 millions; butter and cheese, to 1.2, 1.5, 14, and 18 millions; condensed milk, to 1.4, 2, 6, and 18 millions; refined sugar, to 1.9, 18, 43, and 91. The sugar went presumably to England, which was taking 55 million dollars' worth of German sugar as far back as 1913 and must now look elsewhere. The prices assigned this sugar are of interest:

1911	*1912*	*1913*	*1914*	*1915*	*1916*	
1.4	3.6	1.9	18	43	91	million dollars
32	79	52	390	963	1577	million pounds
4.4	4.5	3.6	4.6	4.5	5.7	cents per pound

From this the American housewife may learn that our refiners have had refined sugar to sell abroad in huge quantities at a uniform price from 1911 through 1915, except for a cheapening of a third (33 per cent) in 1913, and that there has been but one increase, that of 27 per cent in 1916. Potatoes were exported at 90, 88, 76, 82, 67, and 122 cents per bushel; butter at 22, 26, 26, 24, 26, and 31 cents per pound. Some very important foodstuffs that were exported in greatly increased quantities did not rise very much in price. For instance, fresh beef was exported at the following prices in cents per pound: 10.7, 11.1, 11.8, 12.4, 12.8, and 12.2; bacon at 12.2, 12.2, 13.1, 13.9, 13.3, 14.7. But lard shows a greater rise: 9.9, 10.5, 11.3, 11.1, 10.7, 13.1. Wheat should have been included among the food substances exported in greatly increased amount, the millions of dollars' worth being 30, 60, 95, 187, 283, and 227, and the prices 110, 97, 95, 107, and 137, and 147 cents per bushel.

Cotton was as always a most important export, falling off greatly in the first two years of the war, but in 1916 coming up nearly to the earlier totals. The values and prices were:

1911	*1912*	*1913*	*1914*	*1915*	*1916*	
517	623	575	344	417	544	million dollars
60	58	67	55	50	78	dollars a bale

Doubtless the decrease in the amount exported in 1914 was caused by the cutting off of the markets of eastern and central Europe. Probably the

Allies used enough in making explosives to make up nearly the whole loss. But why should the price go up in 1916? Pig iron increased in quantity from less than two million dollars' worth in 1911 to nearly 16 million dollars' worth in 1916, and the price from $15.70 to $25.52. With these prices it is worth while to compare the importations of gold:

57 66.5 64 57 452 686 million dollars

To whom have these large exportations of goods from the United States gone? The better to answer this question let us classify the world into Allies, Central Powers, Near Neutrals, and Far Neutrals ("near" and "far" relating to distance from Germany). In detail the Allies are Canada, the United Kingdom, France, Portugal, Italy, Russia, and Japan. The Central Powers for commercial purposes are Germany, Austria-Hungary, and Turkey; the Near Neutrals, Netherlands, Denmark, Norway, Sweden, and Switzerland; and the Far Neutrals, Spain, Cuba, Argentina, and Brazil. The countries omitted are those that have very little commerce. A table is given later with all details, but here the totals (in millions of dollars) may be studied:

		1908	1909	1910	1911	1912	1913	1914	1915	1916
Central Powers	U. S. Exports to	275	266	276	320	357	377	174	12.2	2.2
	U. S. Imports from	132	193	200	202	224	225	183	55	6.6
Allies	U. S. Exports to	933	934	1010	1098	1299	1320	1254	2589	4251
	U. S. Imports from	452	606	640	615	742	737	736	681	908
Near Neutrals	U. S. Exports to	132	118	112	139	145	165	195	354	298
	U. S. Imports from	50	70	74	77	81	84	86	09	94
Far Neutrals	U. S. Exports to	114	121	149	165	188	199	146	229	353
	U. S. Imports from	185	267	284	258	327	276	320	432	526

These figures show that:

(1) Exports to the Central Powers were less than half their usual amount in 1914 and almost nothing in 1915 and 1916. We should expect the 1914 figures to show rather more than half a year's business, as the war did not break out till the beginning of the eighth month of the year. The practical disappearance of exports to the Central Powers resulted of course from the immediate disappearance of the German (and the Austrian) merchant fleet from the seas.

(2) About the same thing happened to the imports to the United States from the Central Powers. But it should be noted that the imports from these countries to us between 1908 and 1913 amounted to about two-thirds of our exports to them. It is usual for all European countries except Russia and Rumania to import considerably more value of goods than they export, as the rest of the world owes them interest on investments, freights, remittances of their emigrants, and payment of tourist expenses, all of which enter into the excess of goods sent to Europe from the ends of the earth. Now in 1914 the importations to the United States from the Central Powers were rather more than half the usual amount, and in 1915 and 1916, although enormously diminished, the amounts were three or four

times greater than the amounts received from us, the usual relation being thus reversed. The British blockade appears to have been more effective in keeping our goods from reaching Germany than in keeping theirs from reaching us; and very likely the principal effort of Great Britain was exerted in that direction.

(3) American exports to the Allied Powers increased strongly from 1909 to 1913. In 1914 they fell below the figures for 1912 and 1913, but were much greater than in earlier years. In 1915 the amount doubled and went a long way toward doubling again in 1916. Thus was the call of the Allies for help met by the United States. If we had figures for Argentina at hand they would probably show something of the same sort, as far as her resources go.

(4) Our imports from the Allies are usually rather more than half the exportations, and increasing. In 1914 they showed a slight diminution and a greater one in 1915, and, though they increased strongly in 1916, they were not a fourth as great as the exportations and were only larger because of the inflation of prices, as has been shown. We sent the Allies great increases of goods in 1915 and 1916 but did not receive more than usual from them. They paid us with gold and returned American securities.

(5) To both Allies and Central Powers we sent less in 1914 than in 1913. To the ring of Near Neutrals, however, that surround Germany and Austria, our exports were a fifth greater in 1914 than in 1913, almost double as much in 1915 as in 1914, and again largely increased in 1916; enough to show that despite the higher prices there was an actual increase of goods sent to these countries. It was these facts that satisfied the Allies that American goods were reaching the Central Powers by way of the Near Neutrals. The failure to drop in 1914 was the most suspicious feature of these sums, seen also in the detail for Denmark, Norway, and Sweden. The following curves of exports bring out the difference:

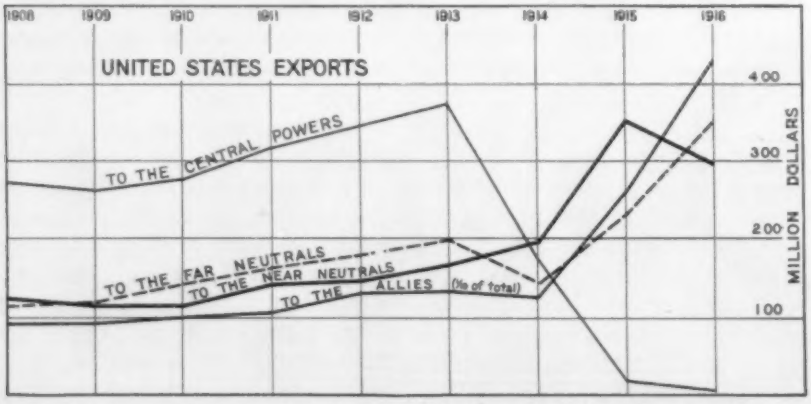

FIG. 3—Diagram showing the effect of the war on United States trade with the various groups of belligerents and neutrals. (To bring the curve within the range of comparison the exports to the Allies have been divided by 10.)

TRADE OF THE UNITED STATES WITH THE VARIOUS GROUPS OF BELLIGERENTS AND NEUTRALS AS AFFECTED BY THE WAR

(Figures denote millions of dollars)

	1908	1909	1910	1911	1912	1913	1914	1915	1916
With the Central Powers									
U. S. Exports to									
Austria-Hungary	15	16	16	21	24	22	13	0.1	0.06
Germany	258	247	258	295	330	352	158	12.0	2.0
Turkey	2	3	2	4	3	3	3	0.1	0.1
	275	266	276	320	357	377	174	12.2	2.16
U. S. Imports from									
Austria-Hungary	14	17	18	16	18	19	16	5	0.3
Germany	128	162	167	166	186	184	149	45	6.0
Turkey	10	14	15	20	20	22	18	5	0.3
	152	193	200	202	224	225	183	55	6.6
With the Allies									
U. S. Exports to									
France	117	126	115	128	155	153	171	501	861
Italy	61	57	53	61	74	79	98	270	303
Portugal	4	3	3	3	3	5	4	9	16
Russia	20	16	19	25	27	27	28	170	468
United Kingdom	554	521	551	599	607	591	600	1198	1888
Canada	153	188	242	299	375	403	311	345	606
Japan	24	23	27	43	58	62	42	46	109
	933	934	1010	1098	1299	1320	1254	2539	4251
U. S. Imports from									
France	89	132	122	122	134	139	104	78	109
Italy	43	50	49	46	52	55	55	51	60
Portugal	5	6	7	6	7	6	6	5	7
Russia	8	16	14	19	28	24	14	3	8
United Kingdom	172	247	271	250	313	272	287	258	305
Canada	71	87	103	94	121	142	164	178	237
Japan	64	68	74	78	87	99	106	108	182
	452	606	640	615	742	737	736	681	908
With the Neutrals Near Germany									
U. S. Exports to									
Denmark	19	15	13	15	16	19	42	74	56
Netherlands	98	89	85	106	110	122	101	143	114
Norway	6	6	6	8	8	9	20	46	66
Sweden	8	7	7	9	10	14	31	85	48
Switzerland	.7	.8	.8	.7	.8	.8	.8	6	14
	132	118	112	139	145	165	195	354	298
U. S. Imports from									
Denmark	1	2	2	2	3	2	4	3	3
Netherlands	20	31	31	34	37	38	37	28	44
Norway	4	6	7	8	8	8	12	7	6
Sweden	4	5	8	8	10	12	12	11	19
Switzerland	21	26	26	25	23	24	21	20	22
	50	70	74	77	81	84	86	69	94
With the Neutrals Far from Germany									
U. S. Exports to									
Spain	21	17	23	24	32	31	28	46	63
Cuba	42	48	58	62	65	73	68	96	165
Argentina	34	36	43	50	51	55	27	53	77
Brazil	17	20	25	29	40	40	23	34	48
	114	121	149	165	188	199	146	229	353
U. S. Imports from									
Spain	12	16	20	21	22	24	22	19	33
Cuba	79	107	128	106	138	125	147	198	244
Argentina	13	27	32	28	34	26	56	95	116
Brazil	81	117	104	103	133	101	95	120	133
	185	267	284	258	327	276	320	432	526
U. S. Trade with									
Near Neutrals	182	188	186	216	226	249	281	423	392
Far Neutrals	299	388	433	423	515	475	466	661	879

The values exported to the Allies are so large that it has been necessary to divide them all by ten to represent them on the same diagram with the other three groups. The Near Neutrals received a considerable increase of goods in the very first year of the war, in spite of the diminution of shipping. This the heavy line shows. Yet the Allies, with complete control of the seas, had their receipts diminished by a fourth. The same heavy line makes it clear that the receipts of Germany through these neutrals have since been much lessened.

(6) Imports of the United States from the Near Neutrals were in the neighborhood of a tenth as large as those of the Allies. Considering the inflated prices of 1915 and 1916, they imply that fewer goods were sent to the United States during the war than formerly. Undoubtedly the Near Neutrals found in Germany a better market for much of their merchandise.

(7) The Far Neutrals are peculiar in their commercial relations with the United States in that our imports from them are greater than our exports to them. This is not true, as the detailed table shows, of Argentina or Spain. To these two countries, as to most countries in Europe, our exports are greater than our imports. But business with Cuba and Brazil is large enough to offset the effect of this. Our exports to the Far Neutrals increased steadily till 1914, when they fell off strongly; but they picked up again with unusual vigor in 1915 and 1916. Considerably more goods were sent to them than before the war.

(8) But the striking thing with these countries is the much greater increase of the imports to the United States from them. Of Spain alone this is not true. Our business with Spain is of moderate amount and grows very slowly and does not appear to be influenced so much by the war as by prices.

In general, American business away from the seat of war is doing very well. We have a hugely increased export business with the Allies, though our business with the Central Powers is almost extinct.

Still, moderate amounts of our goods reach the Central Powers through their neighbors. We have lost some 350 million dollars' worth of direct exports to them against a gain through their neighbors of about 100 millions. As for the Central Powers, they are deprived of much-needed supplies in addition to the loss of markets for what stocks of manufactures they may have in hand that they cannot use. When the war closes Germany will want large shipments of American goods and will wish to send us German goods to pay for them.

THE VOLCANIC ACTIVITY OF MOUNT ST. HELENS AND MOUNT HOOD IN HISTORICAL TIME

By WILLARD ROUSE JILLSON

Not a little has been written in one form or another concerning the prehistoric and recent activity of those splendid volcanic cones of the Cascade Mountains which stand like sentinels on guard at the gateway of the Columbia River. Mount St. Helens (9,750 feet) in Washington is about forty miles north of the Columbia, and Mount Hood (11,225 feet) in Oregon is about twenty miles south. By reason of their dominant size (Vancouver reported Mount Hood to be 25,000 feet high), their beauty, and their relative position, these mountains have been called the "Guardians of the Columbia." About their magnificent, perpetually snow-clad peaks is woven a wealth of legend and description, which antedates the arrival to this North Pacific coast of the first intrepid Spanish and English explorers.

Perhaps the most unreliable, though not the least picturesque, source of information concerning the activity of these old volcanoes is to be found in the tradition and tribal lore of the Puget Sound, Columbia River, and coastal Indians. These primitive peoples, after nearly a century of contact with civilization, still speak with mingled awe and reverence of the "Fire Mountain" (Mount St. Helens) and the "Mountain That Was God" (Mount Rainier). Captain J. C. Frémont in his exploration camp on the Columbia River on November 27, 1843, wrote in his diary[1] with respect to Mount Hood and Mount Jefferson, the next prominent volcano to the south, "The Indian superstition has peopled their lofty peaks with evil spirits, and they have never yet known the tread of a human foot." The original diary of Lewis and Clark,[2] who reached the mouth of the Columbia in December, 1805, also alludes to this characteristic superstition. It does not refer, however, to volcanic activity in either Mount St. Helens or Mount Hood. S. F. Emmons in a report on "The Volcanoes of the Pacific Coast of the United States" says[3]:

> Even our half-civilized Indians of the Northwest, in spite of their association with the white man, cannot be induced, by hope of reward or fear of punishment, to approach the snow-covered peaks in their midst, whose actual manifestations of volcanic energy must exist in their minds as dim traditions.

The first authoritative reports of volcanic activity of these Columbia

[1] Report of the Exploring Expedition to the Rocky Mountains in the Year 1842, and to Oregon and North California in the years 1843-44, Office of Explorations and Surveys, War Department, Washington, 1845; reference on p. 199.

[2] Original Journal of the Lewis and Clark Expedition, 1804-1806, edit. by R. G. Thwaites, 7 vols. and atlas, New York, 1904-05; reference in Vol. 3.

[3] *Journ. Amer. Geogr. Soc.*, Vol. 9, 1877, pp. 45-65; reference on p. 45.

River volcanoes come from the same source. A little farther on[4] Emmons says:

> Mt. St. Helens, on the other hand, is remarkable for its regular conical shape. It is . . . the only peak of which I was able to get a definite account of an eruption. I was told by an old French Canadian voyageur, formerly in the employ of the Hudson's Bay Fur Company, that St. Helens was in active eruption in the winter of 1841-2. To use his expression, the light from the burning volcano was so intense that one could see to pick up a pin in the grass at midnight near his cabin. . . .

Captain Frémont, again, writes[5] under the date of November 13, 1843:

> Wherever we came in contact with the rocks of these mountains, we found them volcanic, which is probably the character of the range; and at this time, two of the great snowy cones, Mount Regnier [Mount Rainier] and St. Helens, were in action. On the 23d of the preceding November [Nov. 23, 1842], St. Helens had scattered its ashes, like a light fall of snow, over the Dalles of the Columbia, 50 miles distant. A specimen of these ashes was given to me by Mr. Brewer, one of the clergymen at the Dalles.

Evidence in corroboration of this statement and date is to be found in various sources, the most authoritative of which is the following. The Rev. J. L. Parrish of Salem, Oregon, writing in *Steel Points*, a Portland (Ore.) mountaineering quarterly magazine, says[6]:

> . . . On the 22d day of November, 1842, I was in the old Mission house, ten miles below Salem, with several other missionaries. . . . I stepped outside and noticed the eruption of Mt. St. Helens. . . . We saw arising from its summit immense and beautiful scrolls . . . of steam. Then came a stratum just below . . . which was an indefinite gray. Then down next the mountain's top the substance emitted was black as ink. The next day . . . I noticed that she [Mount St. Helens] had changed her snowy dress of pure white for a sombre black mantle. The ashes fell at the Dalles to the depth of half an inch. . . . The eruption was on the south side of the mountain about two-thirds of the distance from the bottom to the top.

About sixty miles to the south of Mount St. Helens and just across the Columbia River stands the picturesque cone of Mount Hood, the "Pride of Portland." Geographically and geologically its history is linked with that of Mount St. Helens as well as a number of lesser associated peaks. Its volcanic activity may be traced (if signed reports published in Oregon and Washington newspapers and periodicals may be relied on) to a much more recent date than that of its sister mountain. W. F. Courtney of Walla Walla, Washington, writing of activity in Mount Hood in the *Everett* (Wash.) *Record*, May 17, 1902, says[7]:

> The eruption took place during the latter part of September, 1859. . . . We were camped on Tie Ridge about thirty-five miles from Mount Hood. . . . It was about 1:30 o'clock in the morning . . . when suddenly the heavens lit up and from the dark there shot up a column of fire. With a flash that illuminated the whole mountainside with a pinkish glare, the flame danced from the crater. . . . For two hours, as we watched, the mountain continued to blaze at irregular intervals, and when morning came Mount

[4] p. 53.
[5] *Op. cit.*, pp. 193-194.
[6] Vol. 1, No. 1, pp. 25-26.
[7] Quoted in *Steel Points*, Vol. 1, No. 3, p. 135.

Hood presented a peculiar sight. His sides, where the day before there was snow, were blackened as if cinders and ashes had been thrown out.

Under the title of "Eruptions of Mount Hood" the weekly *Oregonian* (Portland) of August 20, 1859, says in part[8]:

On Thursday night the fire was plainly seen. . . . Yesterday the mountain was closely examined, when it was seen that a large mass of the northwest side had disappeared. . . . The dense cloud of steam and smoke constantly rising over and far above the summit, together with the entire change in its appearance heretofore, convinces us that Mount Hood is now in a state of eruption, which has broken out within a few days.

The most recent recorded activity of Mount Hood occurred September 21, 1865. The *Oregonian* of September 26, 1865, says in part[9]:

It is some time since we have had an excitement about Old Mount Hood belching forth, but on Saturday last the active puffs of dense black smoke were witnessed by hundreds of people in this city.

Farther on[9] it prints a letter from a John Dever, Company E, 1st Regiment Washington Territory Volunteers, written at the Vancouver, Wash., barracks, where he was a part of the guard in the early morning of June 21, 1865:

. . . Judge, then, of my surprise to see the top of Mount Hood enveloped in smoke and flame . . . accompanied by discharges of what appeared to be fragments of rock, cast up a considerable distance, which I could perceive fell immediately with a rumbling noise not unlike distant thunder. This phenomenon was witnessed by other members of the guard. . . .

The probability of the genuineness of these and similar statements will not be questioned by any one who is familiar with the geology and the physiography of Mount St. Helens and Mount Hood. Each of these mountains is a beautifully symmetrical cone the higher elevations of which are only slightly scarred by stream and glacial erosion. Mount Hood is the more sharply pointed, owing to the loss of a part of the crater rim. Both mountains show toward their bases well-developed lateral drains choked with lava flows, minor vents, and "blow holes." In many cases these flows present a most strikingly recent appearance, with bright, new, and strongly outlined surfaces, neither aggraded nor degraded, and barren of any vegetation except the scantiest.

Various travelers, prospectors, and United States army officers who penetrated into the primeval forests of this northwest wonderland have noted these things, and each one has brought back his own story. Lieut. C. P. Elliott, U. S. A., after exploring Mount St. Helens, made a rough reconnaissance topographic map of the area.[10] He noted the choking and damming of the lateral drains and speaks in particular of two instances which have a present bearing. The first one is that of a drain into the Kalama River, where the lava dam has formed the beautiful Lake Merrill ("Trout

[8] Quoted in *Steel Points*, Vol. 1, No. 3, p. 136.
[9] Quoted in *Steel Points*, Vol. 1, No. 1, p. 23.
[10] Mount St. Helens, with map, 1:180,000, *Natl. Geogr. Mag.*, Vol. 8, 1897, pp. 226-230.

Lake,'' by some), which is unique in that it has no surface outlet and appears never to have had one. Speaking of this lava dam he says: ''Further to the north and toward the Kalama River, where the lava flowed over the standing trees (the places of the trunks now forming wells in the lava), running water can be heard.'' Russell, in his ''Volcanoes of North America,''[11] notes that Mount St. Helens, which was ascended as early as 1889, ''seems to have been active in recent years, and is fresher in appearance than Mount Hood.'' He also refers to the lava-damming of Lake Merrill, the lava tree casts, the still active ''fumaroles,'' and the recent ''blow holes'' on the long lava flow on the southwest side of the mountain. Lieutenant Elliott has referred[12] to this lava bed, which finds its origin somewhere near Butte Camp at an elevation of 4,500 feet, and flows and cascades down a number of old valleys for nearly ten miles to the Lewis River, where it terminates in a number of large conical ''blow holes'' at an elevation of 1,000 feet. Its principal course lies between Cougar Creek and Big Creek, mainly in two large drains, one of which supplies the underground water for Lost Creek. Incidentally this superb lava flow is chiefly notable throughout the Northwest for its great cave, over a mile in length and one of the largest of its kind in North America.[13] This flow has been identified as the one referred to by Frémont, Parrish, and Emmons as being active on November 22, 1842, and also possibly in 1841.

The summer of 1915 was spent by the writer in studying in the field the geology and physiography of Mount St. Helens and its environs. On August 5, 1915, the summit was reached after a hard two hours' climb from Butte Camp. Previous to this, three weeks had been spent at an elevation of 4,000 to 7,000 feet, where many evidences were found of recent mild eruptions. Among other things of interest disintegrating charcoal and wood fiber in one of the horizontal lava tree casts in the great flow of the southwest side of the mountain were discovered. This evidence is made the subject-matter of another paper, ''New Evidence of a Recent Volcanic Eruption on Mount St. Helens, Washington.''[14] The importance of this discovery was anticipated by J. S. Diller, who speaks[15] at length as to the value of these lava tree casts. His deductions, made from a résumé of the better known literature, are that mild eruptions of diminishing strength and duration have most likely occurred on Mount St. Helens within the last century.

In conclusion it seems worth while to call attention summarily to the following facts. The separate and unrelated reports and statements of Frémont, Emmons, and Parrish fix without question the date of November 22, 1842, as one of considerable volcanic activity of an eruptive and extru-

[11] New York, 1897, p. 241.
[12] *Ibid.*, p. 228.
[13] The Lava Caves of St. Helens, *Mazama*, Vol. 2, 1900-05, pp. 134-135.
[14] *Amer. Journ. of Science*, in press.
[15] Latest Volcanic Eruptions of the Pacific Coast, *Science*, Vol. 9, 1899, pp. 639-640.

sive nature on Mount St. Helens. The reports of Diller, Elliott, and others establish without doubt the recency of such volcanic activity. In consideration of the charcoal and wood fiber in the lava casts it may be that the last ebbing tide of extrusive vulcanism of Mount St. Helens continued on in a feeble, localized, and intermittent way until well into the third quarter of the nineteenth century, as published observations have shown to have been the case with Mount Hood. In the light of this suggestion it is interesting now to reconsider causally what vital rôle may have been played in the lives of the early natives of this part of the Cascade Mountains at no really distant date by these two "Guardians of the Columbia."

GEOGRAPHICAL RECORD

NORTH AMERICA

The Aërial Defense of the Coasts of the United States. To the two traditional branches of our national defense service it is now proposed to add a third. It is argued by Rear Admiral Robert E. Peary, and the present war has fully demonstrated the strength of his contention, that the command of the land and the sea is more than worthless, it is impossible, without the command of the air. The Sheppard-Hulbert Bill, before Congress, would provide a Department of Aëronautics, and through this it is proposed to develop a comprehensive aëro coast-defense system of patrol. The system would comprise a continuous cordon of sentinel planes a hundred miles or more off the coast and large aëro-squadron stations near all the principal coastal cities, to protect the cities from air raids and to carry out offensive operations against hostile fleets and their attendant air squadrons. The air scouts would also convoy merchant and troop ships, serve as the eyes of mine layers, search out submarine bases in highly indented coasts, locate submerged mines, and assist ordinary craft in naval engagements. At least two thousand sea planes are required for each coast. The *Emden*, the *Moewe*, the *Appam*, and other raiders have demonstrated that it is easy for enemy craft, under cover of night or thick weather, to creep close inshore unperceived. A single one of these steamers could bear fifty warplanes. In addition, each of the larger enemy submarines could carry planes, equipment, and ammunition. In the face of these real dangers, and in line with the development of air service abroad, the tactical study of air control and the meteorological factors involved is one of the major defense problems of the day. (For details see the following articles by Rear Admiral Peary: Command of the Air, *Senate Document No. 687, 64th Congress, 2nd Session*, Washington, 1917; Air Power for the United States, *Saturday Evening Post*, May 12, 1917, pp. 10 *et al.;* also a report of the Advisory Committee on Aëronautics by Murray Hulbert in the House of Representatives, April 13, 1917, printed in the *Congressional Record*.)

Food Production on Reclaimed Land in the West. Secretary Lane of the Department of the Interior has issued an appeal and a warning to the owners of unused but reclaimed land in the West. There are 700,000 acres of land on government projects for which reservoirs have been built, water accumulated, and ditches dug, but which have not been put under cultivation. It is estimated that this land would produce fifteen million dollars' worth of food each year, or an amount capable of feeding twenty thousand families and also an entire army division at the front. The lands now belong to private owners, but Secretary Lane warns them that no one is at present entitled to that which he does not use and that if the property is not made food-producing the time may not be distant when confiscation and government cultivation may be necessary (*Official Bulletin* [the new government organ, published daily by the Committee on Public Information, which is "designed to inform the public on the progress of the war and of official acts incident to its prosecution"], May 10, 1917, Vol. 1, No. 1, p. 3.)

The Opening of the Hell Gate Bridge in New York City. On April 1 the Pennsylvania Railroad Company opened the Hell Gate Bridge. With its single span of 1,000 feet this is the greatest arch bridge in the world. It has, however, an interest beyond that of a great engineering achievement: it is a work of national importance. Its completion permits an all-rail route along the entire Atlantic coast of the United States from Key West to the Canadian border and beyond to St. John, Halifax, and Sydney, Cape Breton. Heretofore transportation along this route has been broken by the water barriers that surround New York City. The stages by which they have been overcome—the train-ferry carrying the "Federal Express," the Hudson and East River tunnels—are indicated by Ellsworth Huntington in his article "The Water Barriers of New York City" (*Geogr. Rev.*, September, 1916). The map accompanying the article shows the location of the bridge: it unites the mainland in the southern part of Bronx Borough with the northern shore of Long Island via Ward's and Randall's Islands and thus provides connection with the main line of the Pennsylvania Railroad. Today the strategic consequences of the opening of the bridge are perhaps the most arresting, yet the facilitation of commercial movement should not be overlooked. By the connecting railways on Long Island and the short car-ferry between Bay Ridge at the extreme west of the island and Greenville Pier on the New Jersey shore freight will be saved the long passage through the East River (S. A. Bonnaffon: Hell Gate Bridge, *Commercial America*, April, 1917).

An Archeological Expedition to One of the Zuñi Pueblos. Our knowledge of the geography of Arizona and New Mexico had its beginning in the report of the journey

of Fray Marcos de Niza in 1539 and in the various chronicles of the famous expedition of Francisco Vasquez de Coronado in the year following. Fray Marcos drew his remarkable outward journey to a close when he viewed from a height in western New Mexico a large pueblo of the Zuñi Indians, that one of the "Seven Cities of Cibola" known as Hawikuh. In 1540 Coronado's advance guard stormed and captured the village, in which action the leader almost lost his life. At this period Hawikuh, or Granada as Coronado named it, consisted of 200 houses, or probably 800 to 1,000 inhabitants. In 1629 the pueblo became the Franciscan mission of La Concepción, and in 1670 it was raided by the Apache or the Navaho, the priest killed, and the pueblo abandoned, although it may possibly have been occupied from time to time during the next ten years, but certainly not after the great Pueblo revolt of 1680.

After this lapse of 237 years, Hawikuh is about to take on new life, so to speak, for a joint expedition has been organized by the Museum of the American Indian, Heye Foundation, of New York, and the Bureau of American Ethnology of the Smithsonian Institution at Washington, for the purpose of completely excavating the ruins of this extensive settlement. The work will be conducted under the personal supervision of Mr. F. W. Hodge, Ethnologist-in-Charge of the Bureau of American Ethnology, assisted by Mr. Alanson Skinner of the Museum of the American Indian. By reason of the fact that Hawikuh was inhabited from prehistoric times until 130 years within the historic period, its ruins afford an excellent opportunity for a study of the effect of contact on the Indians by the early Spanish explorers and missionaries, as well as of the culture status of the Zuñi people at the time they first became known. The expedition has been made possible largely by the patronage of Mr. Harmon W. Hendricks, a trustee of the Museum of the American Indian, who has generously offered to bear the field expenses during the season of 1917.

SOUTH AMERICA

The Impending Rapprochement of Chile and Peru. The early renewal of diplomatic relations between Chile and Peru, recently forecast in the press (*New York Times*, April 20, 1917), recalls what is doubtless the most interesting problem in political geography in all South America. The rich and disputed nitrate territory of northern Chile, forcibly seized by that nation in the war with Peru in 1879-83, was never returned to its owner. A promised plebiscite was never held. Each nation has accused the other of "planting" colonists in the disputed territory against the day when a deciding vote should be taken. First one nation and then the other has concentrated troops in the direction of the frontier for years. Among minor troubles may be mentioned a single episode in 1911. Dock laborers at Mollendo refused to unload Chilean vessels for several days, with the result that cargoes destined for Bolivia were carried to Valparaiso and back again, at the consignee's expense. Riots at Arica and Iquique in the same year were followed by the return of Peruvian settlers. In spite of the threat of war, fat revenues have accrued to the Chilean treasury.

Bitterness between the two neighboring countries has been marked by the resignation of one Peruvian ambassador after another as each failed to secure the return of the "unredeemed" national lands. So the Tarapacá-Tacna region has been called the Alsace-Lorraine of South America. But both nations are small and relatively weak, and in later years, with Peru and Colombia in serious and, at one time, in armed dispute over the Putumayo rubber country, the nitrate region resembled rather the Balkan hotbed than Alsace-Lorraine. Thanks to the present war the principle of sympathetic co-operation between small states has gained immeasurably in popular esteem. The South American republics have sought friendly counsel of each other. If peace and cordiality should become a mutual and living force in Peru and Chile the hardships which the war has brought their peoples will seem a small price to pay.

Return of Dr. Hamilton Rice's Expedition from the Amazon. Dr. Hamilton Rice, a Councilor of this Society, returned to New York on April 24 from his expedition to the Amazon on the steam yacht *Alberta*, which he had chartered for that occasion (see the December, 1916, *Geogr. Rev.*, p. 467; to the list of members of the staff there given add Dr. Robert A. Lambert, pathologist at the Presbyterian Hospital, New York City; John W. Swanson, wireless expert; John C. Couzens, engineer and in charge of launch).

The Amazon River was ascended to Iquitos in Peru, a distance of 2,100 miles from its mouth, and the upper portion of the river from Manáos to Iquitos, known as the Solimões, was charted and a tracing made of the channel the yacht followed. The navigable course varies greatly from year to year, and it was thought that a series of charts, if taken over a consecutive number of years, would show the tremendous

activity of the river, due to its immense volume, its rapid current, the quantity of detritus it carries, and the quality of the land through which it flows. It is here that lateral erosion and fluvial activity in general can be studied on a stupendous scale.

The *Alberta* is the first yacht to ascend to Iquitos. In 1898 the U. S. gunboat *Wilmington* and in 1909 the British gunboat *Pelorus* went up the river to this point. It was also about 1898 that Commodore Benedict in the *Oneida* ascended as far as Manáos. Ceroncio Mello, an expert who knows the river from Pará to Iquitos, piloted the *Alberta*. He was also pilot of the *Pelorus* on her voyage in 1909. Some idea of the skill and remarkable qualities of the Amazon pilots may be had from the fact that they have no charts but are dependent solely on memory and an extraordinary ability in judging the ever-changing main navigable channel from the condition of the banks and the movements of the currents.

On the return to Manáos from Iquitos the river boat *Inca* was chartered and the Rio Negro ascended to Santa Isabel, 425 miles above Manáos. Lashed to the *Inca* were the launch *Eleanor*, a staunch craft especially constructed for the work by the Seabury Company of New York, and a steel *varenga*, or lighter, employed for extra supplies, fuel, etc. From Santa Isabel to the mouth of the Caiary, or Uaupés, the largest right tributary of the Negro (explored by Dr. Rice in 1907-08), the river bed is filled with rocks, and several *cachociras*, or bad rapids, occur, those between Camanáos and São Joaquim forming a stretch of over 30 miles of broken water, foaming rapids, whirlpools, and cross currents. It was impossible to take the lighter beyond Camanáos, but the launch passed up to São Gabriel without accident and fell back again to get supplies from the cache at Camanáos. On the second ascent in one of the first stretches of bad water the launch sustained several bad knocks and a hole was punched amidships on the starboard side, but she managed to reach São Gabriel. Here temporary repairs were made and she was taken down river to Umarituba, where more thorough work was possible. During this delay the river fell steadily, and on the launch's return from Santa Isabel it was impossible to ascend above Camanáos.

An attempt was then made to ascend the Padauiry, a left tributary of the Negro farther downstream, but a huge sandbank completely choked the mouth of the Prêto, into which the Padauiry discharges just above the former's confluence with the Negro, and this plan had also to be abandoned. Descent was then made along the north bank of the Negro back to Manáos. It was along this shore that Dr. Alfred Russel Wallace tried unsuccessfully to descend in 1851, and Spence refers to it as *terra incognita*.

The objects of the expedition were: (1) A topographical, hydrographical, and geological survey of the Rio Negro, the investigation of its analogies and differences in relation to the other big tributaries of the main river, and the construction of a detailed map. (2) To test the practicability of receiving signals from Radio, Virginia, with a portable field wireless set, thus simplying the usual method of determining the differences of meridian distances by employing Washington as the prime meridian with which to compare the field stations of secondary and tertiary meridians. (3) An inclusive investigation of the diseases of the river, their etiology, prevalence, and prevention.

AUSTRALASIA AND OCEANIA

A Unique Grassland in New Zealand. About one-seventh of the occupied surface of New Zealand is characterized by the plant formation known as montane tussock grassland. On the eastern slopes of the Dividing Range it stretches in an almost unbroken band from the Wairau River in the north of South Island to the heavily wooded mountains of Southland, occupying a zone between the agricultural lowlands to the subalpine highlands. Patches of southern beech forest in favored locations are the sole interruptions. This grassland appears to represent the ultimate formation in the natural vegetative cover. Moreover it apparently survives man's intervention in an extraordinary manner. Despite burnings, grazings, and other usually destructive operations it is today little different from what it was half a century ago. Its value, however, is comparatively low; whence arises the question of possible improvement. The carrying capacity, even where supplemented by summer grazing on the subalpine pastures, is not more than one sheep to three acres, and from the total area of six million acres the wool production averages two and a half pounds per acre per year, a return greatly inferior to that from any other of the occupied lands. The nature of the land tenure (short leasehold) and the great size of the individual runs are partly responsible for retarded developments, and as yet no experimental work has been done with a view to determining suitable species for introduction into this distinctly xerophytic grassland (A. H. Cockayne: Some Economic Considerations Concerning Montane Tussock Grassland, *Trans. and Proc. of the New Zealand Inst.*, New Issue, Vol. 48, Wellington, 1916).

Exploration in Southern Papua. The Society has received from one of its Life Fellows, Dr. Arthur Wade of Australia, a valuable though brief account of his latest detailed surveys in Papua, or British New Guinea. The communication is dated February 1, 1917. His expedition of 1916 met with new peoples from among the mysterious Kuku tribes, whose customs are extraordinary even for Papua. They inhabit the hill country at the headwaters of the Vailala River and have only recently been persuaded to venture below the rapids that occur at the Puve Hills above the deserted village of Me. In addition to a polished bone piercing the septum of the nose, they insert long vegetable fibers, which give their faces a catlike appearance. Their canoes are simple dugouts without outrigger and are decorated in blood or vegetable stain, with drawings of fish, birds, crocodiles, and their common food plants. Before the time of Dr. Wade's expedition this type of canoe was wholly unknown on the Vailala River, and indeed it is doubtful if it has yet been discovered anywhere else in Papua. The results of the surveys will be represented on topographic maps which will throw light on the structure and origin of hitherto unknown areas. Raised beaches, river terraces, and deserted river beds show that the region has been rising rapidly in recent times and that the movement still continues.

Dr. Wade's former expedition of 1913-14 to the coastal belt about Port Moresby was noteworthy in its results. Three thousand square miles of trackless jungle and sago swamp were surveyed and the coast line between the Purari delta and Yule Island accurately mapped for the first time. The maps, on the scale of 2 miles to the inch, are included in the "Report on Petroleum in Papua" *(Australian Parliamentary Paper, 1914-15, No. 61, F 5163)*. This report also contains important short sections entitled "Climate and Health" and "Native Labor."

The discoveries of Dr. Wade again illustrate the unknown character of much of the interior of New Guinea, the second largest island in the world, and enhance the interest in Dr. Eric Mjöberg's proposed aërial expedition, described in the February *Review* for this year.

Abnormal Rainfalls in Australia. From Mr. H. A. Hunt, Commonwealth Meteorologist of Australia, there have recently been received newspaper reports concerning some phenomenally heavy rainfalls in Victoria and New South Wales. About the middle of September, 1916, there began a great drift of warm, moisture-laden air, coming from the equatorial oceans north of Australia, southward over the eastern half of Australia. This movement extended much farther south than usual and was long-continued. Reaching high, and cooler, latitudes, the moisture in the warm air was condensed and fell as rain. For about two weeks a trough of low pressure extended from north to south across eastern Australia. This depression moved very slowly, and this fact accounted, at least in part, for the phenomenal rainfall. The distance traveled by the depression in a week was 500 miles, while the usual rate of progression is 400 miles a day. The total downpour was tremendous and established a "record" in many sections. The Commonwealth Meteorologist estimates (1 cubic foot of water = 62½ pounds) that over 400,000 square miles of Victoria and New South Wales the rainfall was nearly 4 inches. This represents a fall of roughly 100,000,000,000 tons of water; 250,000 tons to the square mile, or nearly 400 tons per acre. Enough water fell to fill the Assuan reservoir more than one hundred times.

Other depressions, coming also from the north, followed the remarkably rainy period of September and gave an altogether abnormally wet spring. While no positive statement can be made as to cause, it appears likely that the great southward movements of the air, which gave the heavy precipitation, resulted from an abnormal "sagging" to the southward of the thermal equator. In two and a half months, it is estimated that eastern Australia received 800,000,000,000 tons of water, nearly all drawn from tropical seas (1 inch of rainfall = 100 tons per acre, and 64,000 tons per square mile). This was equal to about 45,000,000 gallons per head of the population of the area over which the rain fell. The total fall was equal roughly to 180 billion gallons.

R. DeC. Ward.

HUMAN GEOGRAPHY

Climate and Human Evolution. In a recent paper Professor Joseph Barrell offers an interesting hypothesis as to the way in which man first came down from the trees to walk upon the solid earth (Probable Relation of Climatic Change to the Origin of the Tertiary Ape-Man, *Scientific Monthly*, January, 1917). It is now generally conceded that the great change from a four-handed, unintelligent, apelike, and arboreal creature to an intelligent manlike creature who walked on two feet and worked with two hands occurred in some part of Central Asia beyond the limits of the tropics. Pro-

fessor Barrell believes that the original man-ape would never have left the trees except under the strongest compulsion, for life on the ground is extremely dangerous for so poorly defended a creature. If the forest which formed the apes' home were to disappear, however, and he could not migrate to some other forest, he would be forced to the ground. In the Miocene period the uplifting of the Himalayas and other great ranges apparently raised an impassable barrier between northern and southern Asia. At the same time the climate of the regions north of the mountains became dry. Hence the forests gradually disappeared. Man could not follow them southward because of the mountains. Therefore, according to Professor Barrell, he was more and more compelled to betake himself to the ground. This subjected him to such extreme dangers that the cleverer, more quick-witted types—the ones that had the sense to use sticks and stones or to deceive their enemies—had a tremendous advantage. Hence mental development was at a great premium, and the human brain evolved with remarkable celerity.

A later, but nevertheless remote, phase of the effect of climate on man's evolution seems to be pictured in the ancient holy books of Persia. In a paper entitled "Iranian Migrations before History" (*Scientia*, Bologna, February, 1916) Mrs. Maunder recounts a tradition which was already hoary when put into fixed form about 2,500 years ago. The Venidad, or ancient Anti-Demonine Law of Persia, describes sixteen good lands. The first and best of these, Airyana Vaego, was so full of "flocks and herds, men, dogs, and birds, and red blazing fires," that there was no room for more. At that time the hero Yima was warned of the approach of "fatal winters . . . that shall bring the fierce, foul frost, . . . that shall make snowflakes fall thick." Airyane Vaego became a place where "there were ten months of winter, two summer months," where "winter falls . . . with the worst of plagues." Where was this cold region? A student of Indian mythology might answer that it was in the Himalayas, for the ancient books of Kashmir preserve a similar tradition. Mrs. Maunder answers differently. She cites the tradition of a land in which the summer day is twice as long as the summer night. That would be about latitude 49° or higher. A still more northern location, however, is suggested in Venidad, for in the land whence Yima migrated "the stars, the moon, and the sun are only once [a year] seen to rise and set, and a year seems only a day." Such a description, Mrs. Maunder believes, could apply only to a region north of the Arctic Circle, where day and night each endure for months. Hence she concludes that at some time during their history the Iranians must have dwelt north of the Arctic Circle and that at that time the climate must have been much milder than at present. Later the advent of a glacial epoch or at least of a severe glacial stage—although these terms are not used—drove the people out of their inter-glacial homes.

Other parts of the old Iranian books relate how the people longed for rain through the spring and eagerly awaited the first heavy downpour about the time of the summer solstice. The reference is obviously to the monsoon rains of India. From the far north the Iranians were apparently driven to India, where they remained long enough so that their traditions became saturated with the idea of summer rains, a thing unknown in Iran. There seems good reason to accept Mrs. Maunder's idea that the traditions point to extensive migrations due to alternate epochs of stormy and of mild climate. A long residence of the primitive Iranians north of the Arctic Circle may be questioned, but if their main home was in the Altai region, for example, small bodies of wandering hunters may often have pressed so far north that they were familiar with the midnight sun.

ELLSWORTH HUNTINGTON.

GEOGRAPHICAL NEWS

A New Series of Topographical Bulletins. The National Highways Association has for some years been promoting the improvement of the main roads of the United States. To this end it enlisted the assistance of a large body of experts, which were organized into various divisions. Professor W. M. Davis is chairman of the division of physical geography, which has begun the publication of a series of special bulletins. *Physiographic Bulletin No. 1*, dated May, 1917, has just appeared. In it Professor Davis has performed the useful service of emphasizing the need for a more rapid survey of our national domain, only forty per cent of which has been topographically surveyed. The work is important from many aspects, but chiefly from that of preparedness and of travel and economic development. This first bulletin contains striking reprints from sixteen sheets of the topographical map of the United States already published by the U. S. Geological Survey. They are intended to show interesting portions of mountain and coast line and are accompanied by running comments greatly condensed in form. The bulletin closes with an appeal for the wider use of the maps of the U. S. Geological Survey and for their study by local organizations, as for example, the Boy Scouts.

Summer Session Courses in Geography

(Unless otherwise noted, the instructors belong to the faculty of the institution at which they are giving courses)

University of Alabama, University (June 5–July 18).
General Geography. Miss S. E. Luther of the Conecuh County High School, Castleberry, Ala.

Boston University, Boston, Mass. (July 2–August 11).
Economic History of the United States. Asst. Prof. C. P. Huse.

California State Normal School, Chico (June 4–?).
Geography. Mr. C. K. Studley.

University of California, Berkeley (June 25–August 4).
Physical Oceanography, Including Some Related Phenomena of Meteorology. Dr. G. F. McEwen of the Scripps Institution for Biological Research.
Economic Geography. Mr. P. S. Barnhart of the Scripps Institution for Biological Research.
The Teaching of Geography in Elementary Schools, With Special Reference to Regional Geography. Miss C. B. Kirchwey of Teachers College, Columbia University.
The Teaching of Geography in Secondary Schools. Miss C. B. Kirchwey.
Principles of Plant Ecology. Prof. Francis Ramaley of the University of Colorado.
Race. Asst. Prof. T. T. Waterman.

University of Chicago (June 18–July 25 and July 26–August 31).
Physiography. Asst. Prof. A. O. Thomas of the University of Iowa. Second term.
Geographic Geology. Prof. R. D. Salisbury, first term; Assoc. Prof. R. C. Moore, second term.
Continental Evolution. Prof. R. D. Salisbury, first term; Asst. Prof. A. O. Thomas, second term.
Meteorology. Assoc. Prof. W. S. Tower.
Distribution and Causes of Rainfall. Prof. Mark Jefferson of the Michigan State Normal College at Ypsilanti. Second term.
Physiographic Ecology. Prof. H. C. Cowles and Dr. G. D. Fuller. First term.
Ecological Plant Geography: Regional and World Problems. Prof. H. C. Cowles. Second term.
Economic and Commercial Geography. Asst. Prof. W. D. Jones.
Conservation of Natural Resources. Prof. H. H. Barrows.
Geographic Influences in the History of the Interior. Prof. H. H. Barrows.
Geography of South America. Assoc. Prof. W. S. Tower.
Northern Europe. Prof. Mark Jefferson. Second term.
Geography of Asia. Asst. Prof. W. D. Jones.
Geography in the Primary Grades: Home and World Geography. Assoc. Prof. Zonia Baber.
Geography in the Grammar Grades: North America. Assoc. Prof. Zonia Baber.
Geography in the Grammar Grades: South America. Assoc. Prof. Zonia Baber.
Geography in the High School. Assoc. Prof. Zonia Baber.
Field Course in Geography in Southeastern Minnesota. Mr. C. C. Colby.
Field Course in Geography in the Mississippi Valley between LaCrosse, Wis., and Minneapolis. Mr. C. C. Colby. July 27–August 23.
Field Course in Geography in the Lower St. Lawrence Valley and the Maritime Provinces. Assoc. Prof. W. S. Tower. Sept. 1–29.

Cleveland School of Education (conducted jointly by Western Reserve University and the Cleveland Normal School), Cleveland, Ohio (June 18–July 27).
Physical Geography. Prof. W. M. Gregory of the Cleveland Normal School and Miss Hungerford.
Industrial and Commercial Geography. Prof. W. M. Gregory and Miss Hungerford.
The Teaching of Geography. Prof. W. M. Gregory and Miss Hungerford.

University of Colorado, Boulder (June 25–August 4).
Principles of Earth Science. Prof. W. E. McCourt of Washington University, St. Louis.
Climatology. Mr. N. E. A. Hinds.
Geographic Influences. Prof. W. E. McCourt.
Industrial Geography. Prof. W. E. McCourt.
Geographic and Geologic Excursion to Interesting Places in Colorado, Utah, and Wyoming. Prof. W. E. McCourt. August 4–28.
Special Lectures: (1) The New Geography; (2) The Face of the Earth; (3) Earth Sculpture; (4) Grand Canyon of the Colorado; (5) Glaciers; (6) Rocky Mountain National Park; (7) Yellowstone National Park. Prof. W. E. McCourt.

Columbia University, New York City (July 9–August 17).
Mathematical Geography. Prof. Harold Jacoby.
Introduction to Astronomy (Adapted for Teachers of Geography). Prof. Harold Jacoby.
Geodetic Surveying. Mr. William Bowie of the U. S. Coast and Geodetic Survey and assistant.
Geographic Delineation and Map Interpretation. Asst. Prof. E. M. Lehnerts of the University of Minnesota.
Physical Geography and Its Economic Aspects. Assoc. Prof. D. W. Johnson and Asst. Prof. E. M. Lehnerts.
The Interpretation of Scenery. Assoc. Prof. D. W. Johnson.
Physiography of the Western United States. Assoc. Prof. D. W. Johnson.
Commercial Geography. Prof. C. T. McFarlane.
Geography of Industry and Trade. Prof. C. T. McFarlane.
Geographic Influences in American History. Prof. A. P. Brigham of Colgate University, Hamilton, N. Y.
The Geography of New York State. Prof. A. P. Brigham.
Economic History of the United States. Prof. E. L. Bogart of the University of Illinois.
Field Work in Physiography in the Environs of New York City and the Eastern Section of New York State. Assoc. Prof. D. W. Johnson and Asst. Prof. E. M. Lehnerts.
Field Work in Glacier National Park. Asst. Prof. E. M. Lehnerts. August 21–September 1 and September 2–14.
Special Lectures: (1) The Philosophy of Present and Prospective Boundaries in Europe, Prof. A. P. Brigham; (2) Turkey and the War, Dr. Ellsworth Huntington of Yale University; (3) Surface Features of Europe as a Factor in the War, Assoc. Prof. D. W. Johnson; (4) An Interpretation of the Scenery of the White Mountains, Prof. J. W. Goldthwait of Dartmouth College; and (5) a series of three lectures on South America, Dr. Isaiah Bowman of the American Geographical Society.

Cornell University, Ithaca, N. Y. (July 9–August 17).
Physical Geography. Asst. Prof. O. D. von Engeln.
Commercial and Industrial Geography. Asst. Prof. O. D. von Engeln.
Physical Geography, Laboratory Course. Mr. E. D. Elston.
Field Course in Geography and Geology. Asst. Prof. O. D. von Engeln.
Meteorology and Climatology. Mr. L. A. Hausman of the State College of Agriculture.
Short local excursions; all-day excursions to Taughannock Gorge and Falls, July 14, Enfield Gorge and Falls, July 21, east shore of Cayuga Lake, August 11 (Prof. V. E. Monnett); and longer excursions to Niagara Falls and Gorge, July 28, and Watkins Glen, August 4.

Dartmouth College, Hanover, N. H. (July 10–August 18).
Physiography. Prof. J. W. Goldthwait.
Anthropology. Prof. H. P. Fairchild.

Harvard University, Cambridge, Mass. (July 2–August 11).
Physiographic Field Studies. Prof. W. W. Atwood.
Research in Structural or Glacial Geology. Assoc. Prof. J. B. Woodworth.
Course in Field Geology in the Rocky Mountains of Montana. Assoc. Prof. J. B. Woodworth. July 6–August 17.
Economic History of Europe and the United States during the Nineteenth Century. Prof. E. F. Gay.

University of Idaho (jointly with the Lewiston State Normal School), Moscow (June 12–July 24).
Advanced Geography. Mr. C. S. Chessman of the Lewiston State Normal School.
Geography for Teachers. Mr. C. F. Chessman.

Northern Illinois State Normal School, Dekalb (June 25–August 3).
Geography. Miss Eva Southworth.
Physical Geography. Miss Eva Southworth.
The Teaching of Geography in the Higher Grades. Miss Eva Southworth.

Western Illinois State Normal School, Macomb (June 11–July 20).
Advanced Physiography. Mr. E. L. Jay.
Meteorology.
Agricultural Geography.
Relation of Geography to Human Life.
Geography in the Grades. Mr. Herbert Bassett.

University of Illinois, Urbana (June 18–August 10).
Field Course in Geology in the Rocky Mountains in Eastern Wyoming. Prof. Eliot Blackwelder. June 20–August 15.
Plant Ecology. Dr. W. B. McDougall.

Indiana State Normal School, Terre Haute (June 18–August 31).
History of the Earth and Its Inhabitants. Prof. B. H. Schockel.
Planet, Earth, Climate. Asst. Prof. W. A. McBeth.
Elements of Geography.
Regional Geography.
North America. Asst. Prof. W. A. McBeth.
Economic and Commercial Geography. Prof. B. H. Schockel.
Historical and Regional Geography of Europe. Prof. B. H. Schockel.

Indiana University, Bloomington (June 14–August 10).
Physical Geography. Assoc. Prof. J. W. Beede.
Economic Geography. Assoc. Prof. J. W. Beede. June 11–August 24.
The Teaching of Geography. Mr. E. E. Ramsey.

University of Iowa, Iowa City (June 18–July 28 and July 30–August 25).
Physical Geography. Prof. A. C. Trowbridge and Mr. W. D. Shipton. First term.
Physical Geography. Dr. M. M. Leighton of Iowa State Teachers' College. Second term.
Geology of Soils. Prof. A. C. Trowbridge and Mr. W. D. Shipton. First term.
Field Course in Geology in the Baraboo, Wisconsin, District (co-operative with the University of Chicago). Asst. Prof. J. H. Bretz of the University of Chicago.
Field Course in Geology around Baraboo, Wisconsin. Prof. A. C. Trowbridge. August 1–31.

Johns Hopkins University, Baltimore, Md. (June 26–August 7).
Physical Geography. Mr. D. G. Thompson of Goucher College.
Economic and Commercial Geography. Mr. D. G. Thompson.

University of Kansas, Lawrence (June 7–July 18 and July 19–August 15).
Physiography. Prof. Erasmus Haworth. First term.
Summer Field Work. Asst. Prof. W. P. Haynes. First term.
Ethnology and Race Problems. Prof. F. W. Blackmar.

Western Kentucky State Normal School, Bowling Green (June 18–July 30).
Geographic Influences in American History. Miss E. C. Semple of Louisville, Ky.
Method in Teaching Geography.
Excursion to Mammoth Cave, June 15–21.

Louisiana State University, Baton Rouge (June 7–August 8).
Physiography. Prof. F. V. Emerson.
Geology and Geography of Louisiana. Prof. F. V. Emerson.

Miami University, Oxford, Ohio (June 11–July 20).
Home Geography. Prof. G. W. Hoke.
Geography of Eurasia. Prof. G. W. Hoke.
Geography of the United States. Mr. S. W. Cushing of the State Normal School, Salem, Mass.
World Geography. Mr. S. W. Cushing.

Central State Normal School, Mount Pleasant, Mich. (June 25–August 3).
Physiography. Mr. G. E. Ganiard, Superintendent of Schools, Mount Pleasant Mich.
Commercial Geography. Mr. R. D. Calkins.
Teachers' Geography. Mr. R. D. Calkins.
Geographic Methods. Mr. R. D. Calkins.

Michigan State Normal College, Ypsilanti (June 25–August 3).
An Elementary Course in Geography. Miss Mabel Weddel.
Physiography of the Lands. Miss Genevieve Clark.
Commercial Geography. Prof. Mark Jefferson.
Geography of Europe. Prof. Mark Jefferson.
Teachers' Geography. Miss Genevieve Clark and Miss Mabel Wedel.
Field Course in Geology in Southeastern Michigan. Prof. W. H. Sherzer.

University of Michigan, Ann Arbor (July 2–August 24).
Teachers' Course in Physiography. Asst. Prof. I. D. Scott and assistant.
Elementary Meteorology. Asst. Prof. I. D. Scott and assistant.
Excursion to Niagara Falls, July 20, and to the island of Put-in-Bay, Lake Erie, August 4. Asst. Prof. I. D. Scott.

University of Michigan (continued)
Special Lectures: (1) Geology of Niagara Falls, July 18, Asst. Prof. I. D. Scott; (2) Geography and Politics, August 6, Prof. R. G. Gettell of Amherst College; (3) The Eskimos of Southern Baffin's Land and of the Belcher Islands of Hudson Bay, July 25, Mr. R. J. Flaherty of Houghton, Mich.

Western State Normal School, Kalamazoo, Mich. (June 25–August 3).
General Geography. Mr. L. H. Wood.
The Geography of Michigan. Mr. L. H. Wood.
The Geography of South America. Mr. C. C. Wilcox of the Kalamazoo High School.
The Geography of Europe. Mr. L. H. Wood.
Commercial Geography. Mr. C. C. Wilcox.
The Geography of American History. Mr. C. C. Wilcox.
Review Geography. Miss Emilie Townsend.
Special Lecture: Physical Barriers and Economic Attractions Which Have Affected the Westward Movement in the United States. Prof. C. H. Van Tyne of the University of Michigan. July 3.

University of Minnesota, Minneapolis (June 19–July 31).
Physiography. Asst. Prof. C. J. Posey.
Teachers' Course in Geography. Asst. Prof. C. J. Posey.
Geography of Latin America. Asst. Prof. C. J. Posey.
Industries and Commerce of the United States. Mr. R. J. McFall.
Economic Geography of Foreign Countries. Mr. R. J. McFall.
Field Work in Glacier National Park. Asst. Prof. E. M. Lehnerts. June 18–July 2.

University of Missouri, Columbia (June 7 to August 3).
Fundamentals of Physical and Human Geography. Mr. M. E. Branom.
Geographic Influences in American History. Mr. M. E. Branom.
Advanced Commercial Geography. Mr. S. T. Bratton.
Geography of North America. Mr. M. E. Branom.
Geographic Field Trip to the Atlantic Coast. Mr. M. E. Branom. August 4–September 1.
Teachers' Geography. Mr. S. T. Bratton.
Economic History of the United States. Asst. Prof. H. A. Wooster.

University of Montana, Missoula (June 18–July 27).
Physiography. Prof. J. P. Rowe, and Mr. E. E. Holmes of the College of Montana, Deer Lodge, Mont.
Geography and Geology of Montana. Prof. J. P. Rowe and Mr. E. E. Holmes.

University of Nebraska, Lincoln (June 11–August 3).
Physical Geography. Miss C. J. Nelson of Teachers College High School.
Regional Geography of North America. Assoc. Prof. N. A. Bengtson.
Geography of European Countries. Assoc. Prof. N. A. Bengtson.
Geography of Nebraska. Assoc. Prof. N. A. Bengtson.
Commercial Geography. Prof. G. S. Stephens.
Elementary Geology, Physiographic, Structural, and Dynamical. Mr. R. W. Ellis.
Geological Excursion to the Black Hills and Rocky Mountain Region. Prof. E. H. Barbour and Asst. Prof. E. F. Schramm.

University of Nevada, Reno (June 19–July 30).
Review and Methods of Teaching Geography.

New York University, New York City (July 2–August 10).
Principles of Economic Geography. Mr. A. M. Nielson.
Special Topics in Geography. Prof. J. E. Woodman.
Research in Geography and Geology. Prof. J. E. Woodman.
Field Course in General Physiography and Geology. Prof. J. E. Woodman.

Northwestern University, Evanston, Ill. (June 25–August 4).
General Geology: Introduction to Geology and the Physiography of the Lands. Prof. U. S. Grant.
Geology and Physiography of the United States. Prof. U. S. Grant.
Race Studies. Prof. S. L. Chandler.

Oberlin College, Oberlin, Ohio (June 15–August 2).
Principles of Geography. Prof. G. D. Hubbard.
Physical, Commercial, and Historical Geography of England. Prof. L. B. Hall.
Ecology. Assoc. Prof. Lynds Jones.

Ohio State University, Columbus (June 21–August 16).
Field Ecology. Prof. E. N. Transeau.
The History of the Westward Movement to 1812. Prof. H. C. Hockett.

Ohio University and State Normal College, Athens (June 23–August 3).
Physiography. Prof. B. M. Thompson.
Physical Geography. Prof. B. M. Thompson.
Political Geography. Prof. B. M. Thompson.
Methods in Geography. Prof. C. L. Martzolff.
Commercial Geography. Asst. Prof. G. C. Parks.

University of Oklahoma, Norman (June 4–July 31).
Physical Geography. Mr. A. J. Williams, Mr. C. E. Decker, and Mr. E. W. Scudder.
Physiography. Mr. A. J. Williams.
Domestic and Foreign Commerce. Assoc. Prof. A. B. Adams.
Territorial Expansion of the United States. Prof. Roy Gittinger.

George Peabody College for Teachers, Nashville, Tenn. (June 16–July 20 and July 21–August 31).
General College Geography. Mr. C. O. Sauer of the University of Michigan.
Economic and Commercial Geography. Mr. C. O. Sauer.
Fundamentals of Regional Geography. Prof. A. E. Parkins.
Influence of Geography on American History, With Special Emphasis on the South. Prof. A. E. Parkins.
Geography of the South. Prof. A. E. Parkins.
The Geography and Commerce of South America. Asst. Prof. G. E. Snider of the College of the City of New York.
People and Industries of South America. Asst. Prof. G. E. Snider.
Geography of Europe. Mr. C. O. Sauer.
Course in Advanced Field Geography either in the southern part of the Appalachian Highland or the area about the Great Lakes. Late July and August, or September.

Pennsylvania State College, State College (June 25–August 3).
Physical Geography. Asst. Prof. L. J. Youngs.
Teachers' Geography. Asst. Prof. L. J. Youngs.
The Teaching of Geography and History. Miss A. U. Wert of the Teachers' Training School, Harrisburg, Pa.
Geography and History in Seventh and Eighth Grades. Miss A. U. Wert.
Economic History of the United States. Dr. A. E. Martin.

University of Pennsylvania, Philadelphia (July 10–August 18).
Physical Geography. Prof. W. M. Gregory of the Cleveland Normal Training School.
Commercial and Industrial Geography. Prof. W. M. Gregory.
The Teaching of Geography. Prof. W. M. Gregory.
Civics, Hygiene, and Geography [course for training of teachers for continuation schools]. Mr. L. A. Lettinger of the Philadelphia Trades School.
The Industrial Environment. Mr. C. E. Reitell.
History of the West, 1837–1873. Prof. L. Paxson of the University of Wisconsin.
The North American Indian. Mr. R. T. Aitken.
Peoples of the Pacific. Mr. R. T. Aitken.

Rhode Island Normal School, Providence.
Methods in Teaching Geography. Mr. R. M. Brown.
Advanced Work in Geography. Mr. R. M. Brown.

University of South Carolina, Columbia (June 20–July 19).
Physical Geography. Prof. A. C. Moore.

University of South Dakota, Vermillion (June 18–July 27).
Geography and the Teaching of Geography. Mr. M. C. Helm, Superintendent of Schools, Pierre, S. D.
Physical Geography and the Teaching of Physical Geography. Mr. M. C. Helm.
Economic Geography. Mr. A. M. Peisch.

Syracuse University, Syracuse, N. Y. (July 9–August 17).
Physiography. Asst. Prof. A. E. Brainerd and Asst. Prof. B. W. Clark.
Physiography of the United States. Asst. Prof. A. E. Brainerd and Asst. Prof. B. W. Clark.
Climatology. Asst. Prof. A. E. Brainerd and Asst. Prof. B. W. Clark.
Industrial and Commercial Geography. Prof. F. W. Roman.
Industrial History of the United States. Asst. Prof. O. E. Randall.
History and Geography of the South American Republics. Prof. A. S. Patterson.

University of Tennessee: Summer School of the South, Knoxville (June 19–July 27).
Home and World Geography (for primary teachers). Miss Bertha Henderson of the Humboldt State Normal School, Arcata, Cal.

University of Tennessee (continued)
North America (for teachers of grammar grades). Miss Bertha Henderson.
Review of Geography. Miss Bertha Henderson.
Geography, History, and Nature Study (for teachers of first four grades). Miss M. L. Cooper of the Memphis city schools.

University of Texas, Austin (June 13–July 26 and July 26–September 4).
General Geography. Mr. E. G. Littlejohn of the Alamo School, Galveston.
Physical Geography. Mr. E. G. Littlejohn.
Geographic Influences in History. Prof. W. L. Fleming of the Louisiana State University. First term.

Tulane University of Louisiana, New Orleans (June 11–July 21).
Geography [principles and teaching methods]. Mr. C. C. Hensen, Principal of the Newman Normal Training School, New Orleans.

University of Utah, Salt Lake City (June 11 to July 20).
Nature-Geography, Story, and Civics [primary teaching methods]. Asst. Prof. Anna Youngberg.
Geography for Grammar Grades. Asst. Prof. Anna Youngberg.
Western History [general development of the Far West from 1790 to the present]. Prof. L. E. Young.

University of Virginia, Charlottesville (June 19–August 2).
Physical Geography. Miss L. C. Kelley of the John Marshall High School, Richmond, Va.
Industrial and Commercial Geography. Miss L. C. Kelley.
Latin American Social Development [a study of the human geography of the Latin-American States]. Adjunct Prof. J. C. Bardin.

University of Washington, Seattle (June 16–July 27).
Physical and Regional Geography. Asst. Prof. E. J. Saunders.
Meteorology and Climatology. Asst. Prof. E. J. Saunders.
Economic Geography of Washington. Prof. Henry Landes.
The Trade of the Pacific. Dr. G. M. Janes.
Spanish-American Civilization. Assoc. Prof. G. W. Umphrey.
Special Lectures: (1) Climatic Peculiarities of Washington; (2) Vulcanism Along the Pacific Coast; (3) Yellowstone Park; and (4) Glacier National Park. Asst. Prof. E. J. Saunders.

University of Wisconsin, Madison (June 25–August 3).
Physical and Applied Geography. Assoc. Prof. Lawrence Martin.
Glaciers and Glaciation. Assoc. Prof. Lawrence Martin.
Commercial and Industrial Geography. Prof. R. H. Whitbeck.
Geography of Wisconsin. Assoc. Prof. Lawrence Martin.
Geography of South America. Prof. R. H. Whitbeck.
Field Course in Physiography and Geology at Devil's Lake, Wisconsin. Assoc. Prof. Lawrence Martin.

Personal

Professor A. P. Brigham of Colgate University has in preparation a volume on the geography of New York State.

Dr. C. F. Brooks of Yale University will be engaged this summer in the Office of Farm Management of the U. S. Department of Agriculture in the application of seed-time and harvest maps to this summer's movement of farm labor.

Professor H. C. Cowles of the University of Chicago lectured on May 11 before the Geographic Society of Chicago on "The Trees of California: A Riddle in Forest Geography."

Mr. G. C. Curtis' model of the crater of Kilauea, Hawaii, has been installed in the geological section of the Harvard University Museum and was put on public exhibition on May 26.

Professor W. M. Davis was awarded the gold Hayden Memorial Medal on February 20 by the Academy of Natural Sciences of Philadelphia "in recognition of his distinguished work in geological science." Professor Davis is for the present occupied with work connected with the Geography Committee of the National Research Council, which has interrupted the completion of his report on the origin of coral reefs, following his Pacific voyage of 1914.

Professor C. R. Dryer is planning this summer to complete his field and research

studies in the physical and economic geography of Indiana and to prepare the results for publication.

DR. O. L. FASSIG of the U. S. Weather Bureau station in Baltimore went to San Juan, Porto Rico, in April on a special mission to extend and reorganize the Weather Bureau service in the West Indies. Meteorological stations are to be established in the newly acquired Virgin Islands and in Haiti, two in the western division of the island and one in the Dominican Republic, at Puerto Plata. The station in San Juan will probably become the center of the West Indian meteorological service.

PROFESSOR G. D. HUBBARD of Oberlin College is engaged in the preparation of a "Physiography of Ohio."

CAPTAIN GUNNAR ISACHSEN, who was a member of Sverdrup's second *Fram* expedition of 1898-1902, recently arrived from Christiania to spend several months in this country. It was Captain Isachsen who on this expedition surveyed Ellef and Amund Ringnes Islands and after whom is named the northwestern cape of the former island, the point jutting farthest into the unknown from this part of the American Arctic Archipelago.

PROFESSOR D. W. JOHNSON of Columbia University is giving, in addition to the summer courses noted elsewhere in this number, a course on "Map Reading and Map Interpretation" in the series of war emergency courses being conducted at Columbia University from May 8 to June 9. This course will be repeated later in the Summer Session. On May 21 Professor Johnson addressed the New York Academy of Sciences on "The Influence of Topography on the Rumanian Campaign." The subject-matter of the address was similar to that of Professor Johnson's article in this number.

MR. P. LEE PHILLIPS, Chief of the Division of Maps and Charts of the Library of Congress, has completed in manuscript a bibliographical account entitled "The First Map and Description of Ohio, 1787, by Manasseh Cutler," to be published by Lowdermilk and Co. in their "Rare Map Series," and "A List of Maps and Atlases Applicable to the World War."

MR. J. W. REDWAY, the author of well-known geographical text books, is at present engaged in researches on the dust content of the air and its relation to the spread of sporadic diseases. His results are being published mainly in medical journals.

MR. W. G. REED, who is at present attached to the Portland, Oregon, office of the U. S. Weather Bureau, is carrying out investigations in the Pacific Northwest to determine the efficiency of the various methods for protecting fruit and vegetables from frost.

PROFESSOR H. F. REID of Johns Hopkins University has been in Europe since the latter part of April as a member of a commission of six sent jointly by the Advisory Commission of the Council of National Defense and the National Academy of Sciences. Professor Reid will study problems connected with photographic surveying from aëroplanes.

DR. V. E. SHELFORD of the University of Illinois will spend the summer investigating the effects of climatic factors on the development of insect pests under the auspices of the Illinois State Laboratory of Natural History. The work will be carried on with the enlarged facilities afforded in the new University Vivarium, where various climatic conditions can be simulated.

MR. EUGENE VAN CLEEF of the Duluth, Minnesota, State Normal School is undertaking this summer a regional study of the Bayfield Peninsula and the Apostle Islands, Wisconsin.

PROFESSOR ROBERT DEC. WARD of Harvard University will give instruction in meteorology in the new school for the preliminary training of aviators, recently established at the Massachusetts Institute of Technology in co-operation with the War Department. In order to carry on this work, Professor Ward has been made a member of the teaching staff of the institute, at the same time retaining his position and carrying on his regular instruction at Harvard. Under orders from the War Department he visited Toronto early in May for the purpose of securing information regarding the instruction which is given there at the school for the preliminary training of aviators carried on by the Royal Flying Corps.

MR. E. H. WILSON of the Arnold Arboretum of Harvard University is engaged in a botanical expedition to eastern Asia. He left the United States in January and expects to return in March or April, 1918. He went first to Japan, then made a journey to the Riu Kiu Islands, a group which has been little visited by botanists. Returning to Japan he visited Oshima Island, a volcanic island south of Yokohama. He is at present in Korea, where he is going to pass the summer and early autumn, and then expects to visit Formosa.

GEOGRAPHICAL PUBLICATIONS

(Reviews and Titles of Books, Papers, and Maps)

For key to classification see "Explanatory Note" in Vol. II, pp. 77-81

NORTH AMERICA

UNITED STATES

North-Central States

WELD, L. D. H., AND OTHERS. **Studies in the marketing of farm products.** 113 pp.; ills. *Univ. of Minnesota Studies in Social Sci. No. 4.* Minneapolis, 1915. 10 x 7.

Beginning with a general discussion of "Market Distribution," this instructive publication treats in detail the marketing of live-stock products, potatoes, and poultry, with special reference to Minnesota; the distribution of milk in Minneapolis and St. Paul; the city market of Minneapolis; co-operative marketing of grain in western Canada; and the food supply of the Iron Range. The basis for the discussion throughout the volume lies in the declaration that "marketing is a part of production," an assumption which the senior author says has not received sufficient recognition by economists.

In the marketing of many foodstuffs, "the part played by transportation costs is almost insignificant when considered as a proportion of final retail prices." Statistics are presented to demonstrate that, in general, the farmer receives 60 per cent of the price for which his product retails. The advantages to be derived from co-operative farming are strongly emphasized and well supported by data.

In many respects the chapter that analyzes "The Food Supply of the Iron Range" is most interesting. The towns are more numerous and are closer together than any other group in the state. On the other hand they are farther from the food-producing area than any other towns. Their presence is due wholly to the iron mines. Since agriculture as yet is a negligible factor, all food supplies must be shipped in. The cost of living on the Range is about 10 per cent higher than in Minneapolis and St. Paul.

E. VAN CLEEF.

ALEXANDER, W. H. **Climatological data: Ohio section.** Maps. *Climatological Data*, Vol. 21, 1916, No. 4 (April), pp. 27-30; No. 6 (June), pp. 43-48; No. 7 (July), pp. 51-56; No. 8 (August), pp. 59-64; No. 9 (Sept.), pp. 67-72; No. 10 (Oct.), pp. 75-80. Weather Bureau, Washington, D. C.

ALVORD, J. W., AND C. B. BURDICK. **Report of the Rivers and Lakes Commission on the Illinois River and its bottom lands, with reference to the conservation of agriculture and fisheries and the control of floods.** 141 pp.; maps, diagrs., ills. Springfield, 1915.

BOYLE, J. E. **Notes from an agricultural field trip across North Dakota.** *Quart. Journ. of the Univ. of North Dakota*, Vol. 7, 1917, No. 2, pp. 177-183.

CADY, G. H. **Coal resources of District VI.** 94 pp.; maps, diagrs., ills., index, bibliogr. *Illinois Geol. Survey Bull. No. 15.* Urbana, 1916. [District VI embraces Jefferson and Franklin Counties and the northern tier of townships in Williamson.]

CADY, G. H. **Mineral production of Illinois in 1909 and 1910.** *Illinois Geol. Survey Bull. No. 20*, pp. 19-42. Urbana, 1915.

CASE, E. C., AND W. I. ROBINSON. **The geology of Limestone Mountain and Sherman Hill in Houghton County, Michigan.** Map, diagrs. *Michigan Geol. and Biol. Survey Publ. 18: Geol. Ser. 15*, pp. 167-181. Lansing, 1915.

COOPER, T. P., F. W. PECK, AND ANDREW BOSS. **Labor requirements of crop production.** 55 pp.; diagrs. *Univ. of Minnesota Agric. Exper. Station Bull. 157.* St. Paul, 1916. ["The data herein presented show the actual labor requirements of farm crops in terms of man- and horse-hours per acre and define some of the principles underlying the use of man labor on the farm."]

FRITSCH, W. A. **German settlers and German settlements in Indiana.** 62 pp. [The Speed Press], Evansville, Ind., 1915. 50 cents. 7 x 5.

HERSEY, H. B. **Climatological data: Wisconsin section.** Maps. *Climatological Data*, Vol. 21, 1916, No. 2 (February), pp. 11-14; No. 3 (March), pp. 19-22. Weather Bureau, Washington, D. C.

HOLAND, H. R. **A forgotten community: A record of Rock Island, the threshold of Wisconsin.** *Proc. State Hist. Soc. of Wisconsin at its Sixty-Third Annual Meeting held October 21, 1915*, pp. 140-150. Madison, 1916. [Island about a mile square in Green Bay, now abandoned, but 70 years ago the home of a vigorous fishing community.]

KAY, F. H., AND K. D. WHITE. **Coal resources of District VIII (Danville).** 68 pp.; maps, diagrs., ills. *Illinois Geol. Survey Bull. No. 14.* Urbana, 1915.

LEE, WALLACE. **The geology of the Rolla Quadrangle.** xii and 111 pp.; maps, diagrs., ills., index. *Missouri Bur. of Geol. and Mines*, Vol. 12, Second Series. Jefferson City, Mo., 1913. [Accompanied by original geological map, 1:62,500.]

MERANDO, SALVATORE. **Gl' Italiani a Chicago.** *Riv. Coloniale*, Vol. 11, 1916, No. 9, pp. 472-478.

MILLER, M. F. **The control of soil washing.** 12 pp.; ills. *Univ. of Missouri Agric. Exper. Station Circular No. 78.* Columbia, 1915.

MILLS, W. C. **Exploration of the Tremper mound (Portsmouth, Ohio).** Maps, diagrs., ills. *Ohio Archæological and Historical Quart.*, Vol. 25, 1916, No. 3, pp. 263-398.

MURPHY, MAURICE. **Some features of the history of Parke County [Indiana].** *Indiana Mag. of Hist.*, Vol. 12, 1916, No. 2, pp. 144-157.

O'BRIEN, F. A. **Names of places of interest on Mackinac Island, Michigan, established, designated, and adopted by the Mackinac Island State Park Commission and the Michigan Historical Commission.** 85 pp.; map, diagr., ills. *Michigan Hist. Commission Bull. No. 5.* Lansing, 1916.

PIERCE, E. D., G. H. SQUIER, AND L. P. KELLOGG. **Remains of a French post near Trempealeau.** Ills., bibliogr. *Proc. State Hist. Soc. of Wisconsin at its Sixty-Third Annual Meeting held October 21, 1915*, pp. 111-123. Madison, 1916. [Probable site of the first (1685-86) and last (1750-55) of the French posts on the Upper Mississippi.]

QUAIFE, M. M. **Index to volumes I-XX of the Wisconsin Historical Collections.** vi and 573 pp. *State Hist. Soc. of Wisconsin Colls.*, Vol. 21, 1915. Madison.

—— **St. Paul, City of: Annual report of the commissioner of public works for the year ending December 31, 1915.** 180 pp.; maps, diagrs. Dept of Public Works, St. Paul, 1915. [Contains several maps of the city, about 1:27,000, giving various data which may be of value in city geography.]

SHAW, E. W. **Newly discovered beds of extinct lakes in southern and western Illinois and adjacent states.** Maps, diagrs. *Illinois Geol. Survey Bull. No. 20*, pp. 139-157. Urbana, 1915. [A more complete presentation than the "Preliminary Statement Concerning a New System of Quaternary Lakes in the Mississippi Basin," *Journ. of Geol.*, Vol. 19, 1911, No. 6.]

SMITH, J. W., AND C. A. PATTON. **Ohio weather for 1915.** Maps, diagrs. *Ohio Agric. Exper. Station Bull. No. 296*, pp. 349-428. Wooster, 1916.

—— **Soil survey reports of Waushara, Waukesha, Iowa counties, Bayfield area, and north part of northwestern Wisconsin.** 394 pp.; maps, ills. **Soil survey reports of Fond du Lac, Juneau, Wewaunee, and La Crosse counties.** 339 pp.; maps, ills. *Wisconsin Geol. and Nat. Hist. Survey Bulls. Nos. 28 and 37, Soil Sur. Nos. 2-6 and 7-10.* Madison, 1913 and 1914.

STEWART, W. P. **Climatological data: Wisconsin section.** Maps. *Climatological Data*, Vol. 21, 1916, No. 10 (Oct.), pp. 75-78. Weather Bureau, Washington, D. C.

VAN DER ZEE, JACOB. **Episodes in the early history of the Des Moines Valley.** *Iowa Journ. of Hist. and Politics*, Vol. 14, 1916, No. 3, pp. 311-347.

WHYTE, W. F. **The settlement of the town of Lebanon, Dodge County.** *Proc. State Hist. Soc. of Wisconsin at its Sixty-Third Annual Meeting held October 21, 1915*, pp. 99-100. Madison, 1916. [The early settlers of Lebanon were lineal descendants of Salzburg emigrants who to escape religious persecution in Austria removed to Brandenburg in the early eighteenth century. For a like reason their descendants emigrated to America a century or more later.]

SOUTH AMERICA

ECUADOR, PERU, BOLIVIA

FERRIS, H. B. **The Indians of Cuzco and the Apurimac.** Map, ills. *Memoirs Amer. Anthropological Assoc.*, Vol. 3, 1916, No. 2, pp. 59-148.

HANDLEY, W. H. **Peru.** 24 pp. *Suppl. to Commerce Repts.*, Ann. Series, 1916, No. 46a, Bur. of Foreign and Domestic Commerce, Dept. of Commerce, Washington, D. C.

HANN, J. v. **Der tägliche Gang des Luftdruckes zu Quito und am Äquator überhaupt.** *Meteorol. Zeitschr.*, Vol. 33, 1916, No. 2, pp. 69-75.

JIMENEZ, C. P. **Estadística minera en 1914.** 150 pp. *Bol. Cuerpo de Ingenieros de Minas del Perú No. 83.* Minist. de Fomento, Lima, 1916.

MARIE, VICTOR. **La producción de algodón en el Perú.** *Bol. del Minist. de Fomento*, Vol. 14, 1916, No. 1, pp. 25-94. Lima. [Reproduced from Bulletin No. 4, 1904.]

REID, W. A. **Bolivia: The heart of a continent.** 53 pp.; map, ills. Bolivian Legation, Washington, D. C., 1916.

—— **Titicaca, La agricultura en la altiplanicie del.** *Bol. del Minist. de Fomento*, Vol. 14, 1916, No. 2, pp. 49-88. Lima. [Discussion of the possibilities of improvement in cultivation of the Titicaca region in view of certain agricultural experiments conducted during the years 1913-1914 and 1914-1915.]

—— ***Cerro Azul Bay, Peru. From a British survey in 1838.*** 1:25,500. *U. S. Hydrogr. Office Chart No. 1757.* Washington, D. C., July, 1916.

—— ***Ecuador, Ferrocarril transamazonico del.*** 1:10,000. Sindicato-Franco-Ecuatoriano de Paris, 1914.

—— ***Talara Bay, Peru. From a British survey in 1909.*** 1:75,000. *U. S. Hydrogr. Office Chart No. 2562.* Washington, D. C., July, 1916.

POLAR REGIONS

ARCTIC

NANSEN, FRIDTJOF. **Spitsbergen waters: Oceanographic observations during the cruise of the "Veslemöy" to Spitsbergen in 1912.** 132 pp.; maps, diagrs., ills., bibliogr., index. *Videnskapsselskapets Skrifter: I, Mat.-Naturv. Klasse*, 1915, No. 2. Christiania.

The Scandinavians have done some of the best work in oceanography—among them Dr. Nansen, zealous, keen observer, critical analyst of data, careful weigher of deductions. This contribution to science is of great value. He views the ocean, as the geologist views the land, as a mass of strata of different thicknesses, horizontal, inclined, with anticlines and synclines and large lentical-shaped sections interlocking like the regenerated drift in glacial gravel beds. This condition is largely due to differences in temperature, varying degrees of salinity, movement of ocean currents, whether tidal, wind-formed, or true currents.

The large number of sections given in the book showing vertical distribution of salinity, isopycnals, and thermal variations are illuminating, and reveal the vast amount of sounding and other investigations necessary for their plotting.

During the northward course of the expedition, several vertical series of observations were made. These demonstrated the tendency of bank-water towards vertical uniformity and showed that these homogeneous masses of water remain over the banks far into the summer. The larger and more shallow the bank, the longer the mass remains. In this conclusion we find food for thought relative to the effect of the bank-water upon the circulation of the Polar Current in the section north of Siberia and possibly an explanation of the excessive zig-zag drift of the *Jeannette* over that of the *Fram*.

The numerous observations made of the Spitzbergen-Atlantic Current for temperature at all depths down to 400 meters and an examination of the water salinity indicate a general law, "that when the temperatures of the deep layers of the sea west or northwest of Spitsbergen decrease towards 1° C., or lower, the salinity has a tendency to approach 34.92%." The same data compared with similar observations made in this area in 1905 show that the Spitzbergen-Atlantic Current had more of an Atlantic character in 1905 than in 1912.

Dr. Nansen found considerable variations in short periods of time of the water strata in the western and northern Spitzbergen fiords, due undoubtedly to horizontal circulation, which in turn was influenced by the tide. The chief cause of the difference in temperature lies in the water on the shelf outside of the fiords and is influenced by the Spitzbergen-Atlantic Current running west around South Cape, and then north as far as Cross Bay.

One point stands out in this work that should be emphasized, namely, that melting ice on the surface has little or no effect upon the underlying strata, as demonstrated by the vertical section of temperatures and salinity percentages made within 100 meters of Lilliehöök Glacier. Here is a subject for further investigation wherever glaciers of considerable size reach the sea. It is the custom of sea captains to "smell icebergs" with thermometers in foggy weather, but they deal only with a thin surface layer shifted with the wind.

Ice prevented penetration into the Deep Polar Basin north of Spitzbergen, but north of Hinlopen Strait Nansen discovered, at 620 meters, a channel evidently communicating with the Polar Basin. The water observed down to 500 meters indicated Atlantic origin and the water below this depth came from the Deep Polar Basin. Nansen draws the conclusion that "The salinity of the water of the Deep Polar Basin is identical with the salinity of the deep-water of the Norwegian Sea."

Under the heading "Extension and Shape of the North Polar Basin" Dr. Nansen gives an illuminating discussion of the work of the *Fram* expedition and criticizes the work of Rollin A. Harris relative to hypothetical land north of Alaska, west of Banks Land and north of Axel Heiberg Land, stating that such land cannot be so near known coasts as assumed by Mr. Harris.

The tides in the North Polar Basin are discussed at length but chiefly from data obtained outside of this particular expedition. Dr. Nansen reviews the data of the famous *Fram* drift of 1896, modifying some of his former conclusions and stating that ice pressures, in the broadest view, are the results of high tides and that much of the slack ice is due to slack water. Here he introduces a discussion of spring and neap tides and their coincidence with high and low ice pressures in the Deep Polar Basin. Indications are that tidal waves in the Deep Polar Basin are larger than have been assumed.

This is a most interesting portion of the treatise. The question can hardly be fully settled by deductions from the data at hand. The drifts of the *Jeannette* and the *Fram* gave a clue to the probable deep water north of the Siberian continental shelf. The drift of the Bryant-Melville casks (as pointed out by the writer of this review in 1907) indicates a shorter route from Alaskan waters to the Greenland-Spitzbergen Passage than that taken by the *Fram*. It indicates a more northern drift of true current character, consequently a broader and deeper basin underlying the casks. This conclusion is substantiated in Nansen's present discussion.

The study of northern oceanography has arrived at the point where a new drift, like the famous *Fram* drift, across the Polar Basin is desirable. This should be much to the northward of the *Fram* route. This was the route that Dr. Nansen intended to follow but he was caught in the ice on the continental Siberian shelf too far to the west.

A final chapter treats of the amount of oxygen in Spitzbergen waters, with some observations on the hydrogen ion concentration in northern sea water. The large number of tables and the 69 scale diagrams, all plotted from Dr. Nansen's soundings, make this work of permanent value to students of oceanography. W. S. C. RUSSELL.

BACKLUND, H. **Quelques données sur l'île de la Solitude (Ensomhed).** *Bull. de l'Acad. Imp. des Sci.* [*de Pétrograd*], 1916, No. 11, pp. 913-919. [In Russian.]

CRAIG, R. M. **Outline of the geology of Prince Charles Foreland, Spitsbergen.** Ills. *Trans. Edinburgh Geol. Soc.*, Vol. 10, 1916, Part 3, pp. 276-287.

—— **Davis Strait and Baffin Bay, Meteorology of.** *Symons's Meteorol. Mag.*, No. 607, Vol. 51, 1916, pp. 100-101. [Abstract of a paper by Captain Campbell Hepworth read at a meeting of the Challenger Society, May 31, 1916.]

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LEVASSEUR, N. **Chez les Esquimaux.** Ills. *Bull. de la Société de Géogr. de Québec*, Vol. 10, 1916, No. 3, pp. 143-146. [A note on the labors of Fabien Vanasse, historiographer to the exploring expeditions conducted by Captain Bernier in 1908-9 and 1910-11 (see "Report on the Dominion Government Expedition to the Northern Waters and Arctic Archipelago of the D. G. S. 'Arctic' in 1910," Ottawa, n. d.). M. Vanasse made a census of the Eskimo groups inhabiting Baffin Land and the south shores of Hudson Strait.]

MATHEY-DUPRAZ, A. **Un voyage dans l'Arctique.** Map. *Bull. de la Soc. Neuchateloise de Géogr.*, Vol. 24, 1915, pp. 5-23.

PEACH, A. M. **The preglacial platform and raised beaches of Prince Charles Foreland.** Map, ills. *Trans. Edinburgh Geol. Soc.*, Vol. 10, 1916, Part 3, pp. 289-307.

RASMUSSEN, KNUD. **De første Thule-Ekspedition frem og tilbage over Inlandsisen.** Maps, ills. *Ymer*, Vol. 35, 1915, No. 2, pp. 133-163.

SPEERSCHNEIDER, C. I. H. **Nautisk-Meteorologisk Aarbog (Nautical-Meteorological Annual), 1914.** 156 pp.; maps. **1915:** 169 pp.; maps. Det Danske Meteorol. Inst., Copenhagen, 1916. [Of special interest on account of the colored maps showing the state of the ice and its geographical limits in the Arctic seas in the period from May to August inclusive, 1914 and 1915.]

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—— ***Spitsbergen, Farvand og ankerpladser paa vest- og nordkysten; optat av Ritmester Isachsens norske Spitsbergenekspedition med marinens D. S. "Fram" 1909-10.*** 1:2,500,000. With inset maps. 1, Forland Sundat—Kings Bay—Cross Bay, 1:200,000; 2, Blomstrand Hamn, 1:25,000; 3, Ferrier Hamn, 1:25,000; 4, Fram Hamn, 1:25,000; 5, Vulkan Hamn, 1:25,000; 6, Green Harbour, 1:100,000; 7, Hecla Hamn—Finnes Hamn i Green Harbour, 1:25,000; 8, Norske Hamna paa Bjørnøya, 1:25,000. Norges Geografiske Opmaaling, Christiania, 1912.

MATHEMATICAL GEOGRAPHY

GENERAL

DE SITTER, W. **On the mean radius of the earth, the intensity of gravity, and the moon's parallax.** *Proc. Section of Sciences, Kon. Akad. van Wetenschappen te Amsterdam*, Vol. 17, Part 2, pp. 1291-1295. June, 1915.

PARESCE, RENÉ. **Une nouvelle méthode de prévision du temps.** Diagrs. *La Nature*, No. 2243, 1916, Sept. 23, pp. 197-199.

SCHOY, C. **Mittagslinie und Qibla: Notiz zur Geschichte der mathematischen Geographie.** Diagrs. *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1915, No. 9, pp. 558-576.

TAYLOR, G. I. **Skin friction of the wind on the earth's surface.** *Proc. of the Royal Soc.*, Series A, Vol. 92, 1916, No. 637, pp. 196-199. [The term "skin friction," taken from mechanics, is here used to express the tangential force exerted by the wind as it blows over a large tract of land.]

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NELLES, D. H. **Photogrammetry for taking topography of watershed.** Diagr. *Engineering News*, Vol. 76, 1916, Nov. 9, pp. 878-880.

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PHYSICAL GEOGRAPHY

METEOROLOGY AND CLIMATOLOGY

QUAYLE, E. T. **A graphical method of showing the daily weather, and especially cloud types.** 6 pp.; map, diagr. *Commonwealth Bur. of Meteorol. Bull. No. 12.* Melbourne. ["The essence of the method is simply to make a rough diagrammatic pen sketch of the cloud as it would appear in section . . . and show the apparent relative levels of the clouds by giving a definite value to the vertical scale of the diagram."]

SHAW, NAPIER. **Note on Mr. Bonacina's paper "On the re-adjustment of pressure differences: Two species of atmospheric circulation and their connection."** *Quart. Journ. Roy. Meteorol. Soc.*, No. 180, Vol. 42, 1916, pp. 229-231.

SWANN, W. F. G. **On the ionization of the upper atmosphere.** *Terrestr. Magnet. and Atmosph. Electr.*, Vol. 21, 1916, No. 1, pp. 1-8.

WENGER, R. **Über den Einfluss der Instrumentalfehler auf die synoptische Darstellung aerologischer Simultanaufstiege.** 16 pp.; diagrs. *Veröffentl. des Geophysikal. Inst. der Univ. Leipzig*, 2nd Series, No. 1. Leipzig, 1913.

HUMAN GEOGRAPHY

ANTHROPOGEOGRAPHY

PETRIE, W. M. FLINDERS. **The revolutions of civilisation.** xi and 136 pp.; diagrs., ills., index. (Series: Harper's Library of Living Thought.) Harper & Brothers, London and New York, 1911. 75 cents. 7 x 4½.

Dr. Petrie in this book propounds a theory, based on the evidences of archeology and of history, which appears to be fundamentally new. Published three years before the start of the great conflagration, the theory seems almost a Cassandra-like prediction of the present upheaval. The book is so "full of meat" that in a short review it is impossible to touch on many of its various points or to do more than briefly to indicate its general trend.

Petrie's main idea is that what we call civilization proceeds in a regular cycle, from a low stage of culture to a high stage of culture, then back again to a low stage of culture. The high stages of culture of various races throughout the world do not coincide. For instance, when feudal central Europe was in a state akin to barbarism, Arab civilization was flourishing in Spain and North Africa.

Each cycle of civilization of a race follows a regular course. On emerging from barbarism, the first product to attain fruition is sculpture, followed in turn by painting; then by literature, then by mechanics and science, then by wealth; after which civilization goes to pieces and returns to barbarism. Government also keeps abreast with civilization in a regular course. It is first an autocracy, then an oligarchy, then a democracy. "When democracy has attained full power, the majority without capital necessarily eat up the capital of the minority, and the civilization steadily decays, until the inferior population is swept away to make room for a fitter people."

Petrie has traced the civilization of Egypt through eight cycles, each of which becomes less distinct as it is further back from us. The seventh Egyptian period corresponds with the last period of European civilization, which brought forth the great sculptures of Greece about 450 B. C., and which ended with the fall of the Roman Empire about 450 A. D. Our own cycle begins with the darkness of the Middle Ages. Gothic sculpture reaches a high stage of development about 1200 A. D., painting about 1400, literature about 1600, mechanics and science about 1900. Judging from precedent—were it not for the Great War—wealth should have a chance of increasing for a hundred or two hundred years more.

Petrie's book arouses a pessimistic and hopeless feeling of the strongest kind about coming generations. For whatever may be the outcome of the present cataclysm it is certainly rushing to destruction the wealth of Europe and of North America. It may be that we are already over the edge, tumbling back to anarchy and barbarism!

EDWIN SWIFT BALCH.

ECONOMIC GEOGRAPHY

General

MITCHELL, W. C. **Business cycles.** xviii and 610 pp.; diagrs., index. *Memoirs Univ. of California, Vol. 3.* Univ. of California Press, Berkeley, 1913. 13 x 10.

Geographers must view with pleasure the extent to which economists are recognizing the importance of the science of geography. A recent review (*Geogr. Rev.*, Vol. 1, p. 192) of Moore's book on "Economic Cycles" showed the close relationship between the average production of crops per acre and the prices of commodities. It also showed that the relationship between crop production and prices is suddenly disturbed at times of panic. The present volume was written before that of Moore, but has not hitherto been noticed in this *Review*. It is interesting as preparing the way for Moore's book and at the same time as giving a comprehensive review of the mechanism of business cycles and of the sudden break which comes at times of panic. The author does not go so far as Moore in attributing the ebb and flow of business to crops, but this seems to be largely because he has not gone into the question of crops so carefully. His main point is that a variation in the production of any commodity or crop disturbs other lines of business and that thus prices may be caused either to rise or fall according to the nature of the disturbances. In his summary he puts the matter thus:

"Many of these divergences among business cycles are due to events which arise

from other than business sources. For the mechanism of the money economy is so delicate that someone's prospects of profits are affected by every day's news. Most important of all these extraneous factors in the long run are the changes of the weather which make crops good or bad, and so affect the prices of farm products, the purchasing power of agricultural communities, the earnings of 'granger' railways, etc." He adds that: "The making of war or of peace, disturbances of domestic order, earthquakes, conflagrations, epidemics, changes in monetary standards, tariff revisions, governmental policies regarding corporations, alterations in the gold output, improvements in industrial technique, the shifting of trade routes—these and a thousand other things can scarcely fail of helping or hampering some business venture. If the circle which they reach be large and their effects pronounced, they doubtless give a peculiar twist to the business cycle within which they fall."

It is noticeable that as the result of a long, exact, and most painstaking study, Mr. Mitchell comes to the conclusion that although such things as war, domestic disorder, tariffs, changes in banking systems, and other things may temporarily cause grave fluctuations in commerce, the crops stand by themselves as the one great cause whose fluctuations man cannot control and which are bound to occur in all parts of the world. While Mr. Mitchell's book consists largely of an economic study of variations in prices, production, imports, bank clearings, employment, manufactures, currency, and other factors, it is well worth study by the geographer who wishes to see how his science is related to daily life.

ELLSWORTH HUNTINGTON.

CLARK, J. B. **[The theoretical side of] The economic costs of war.** *Amer. Econ. Rev.: Suppl.*, Vol. 6, 1916, No. 1, pp. 85-93. [Paper read at the 28th Annual Meeting of the Amer. Econ. Assoc., Washington, D. C., Dec., 1915.]

LANE, F. K. **The contest with physical nature.** *Science*, No. 1101, Vol. 43, 1916, Feb. 4, pp. 158-159. [Address by the Secretary of the Interior before the Mining and Geological Section of the Pan-American Scientific Congress, Washington, D. C., Dec., 1915-Jan., 1916.]

MAYOR, JAMES. **Applied economics: A practical exposition of the science of business with illustrations from actual experience.** xxi and 487 pp.; index. Alexander Hamilton Institute, New York, [1914]. 8½ x 5. [Chapters on the economics of agriculture, production, and transportation.]

ROSSITER, W. S. **The statistical side of the economic costs of war.** *Amer. Econ. Rev.: Suppl.*, Vol. 6, 1916, No. 1, pp. 94-117. [Paper read at the 28th Annual Meeting of the Amer. Econ. Assoc., Washington, D. C., Dec., 1915.]

WHITBECK, R. H. **Economic geography: Its growth and possibilities.** *Journ. of Geogr.*, Vol. 14, 1915-16, No. 8, pp. 284-290.

Production

CLUTE, R. L. **Practical lessons in tropical agriculture: Book II.** x and 258 pp.; diagrs., ills., glossary, index. **Book III.** vii and 251 pp.; diagrs., ills., glossary, index. World Book Co., Yonkers, N. Y., 1916. 7½ x 5½.

These two additional books on tropical agriculture maintain the high standard set in Book I (reviewed in the April, 1916, *Review*, Vol. 1, pp. 327-328). The presentation is attractive, direct, forceful, simple, and instructive. The style is somewhat primer-like, for the volumes are intended as text-books to be used in the schools of the Philippine Islands, where the students, even though advanced, are presumably still developing their knowledge of the English language.

A noteworthy feature is the scheme employed to introduce the student to modern methods of harvesting and other types of work in the light of the antiquated native procedure, without reacting unfavorably upon the native. For example, one reads, "Most rice in the Philippines is harvested by hand." This, after a few qualifying sentences is followed by, "In some countries rice is harvested by a machine that cuts the grain and ties it into bundles." This is further amplified.

Book II describes the mechanics of a farm, presents a detailed account of the leading crops, and briefer statements relative to a group of miscellaneous but nevertheless important products. In Book III, among other things, crop rotation, fruits, forests, domestic animals, and business methods constitute leading topics.

These books are not only replete with information for the agricultural specialist and the layman but also for the geographer who would increase his knowledge of the Philippines in a practical way.

EUGENE VAN CLEEF.

ERRATA

p. 6, title of Fig. 5: *for* Balmadeda *read* Balmaceda.

p. 21, line 9 from bottom: *for* Jornado *read* Jornada.

p. 37, Fig. 10: *the symbol for the Manchester Ship Canal should not be the same as for the other canals, as it did not exist in 1816; its course is merely shown for comparison.*

p. 43, lines 14-15: *for* Board of Education *read* Board of Agriculture.

p. 44, line 9 from bottom: *for* steadily *read* gradually.

p. 52, table, last column, line 1: *dele* Report.

p. 84, line 18: *for* Tip. Calesiana *read* Tip. Salesiana.

Map facing p. 124: *the trifoliate area in the northwestern corner of Arizona should be colored to indicate Western Xerophytic Evergreen Forest.*

p. 140, line 22 from bottom: *for* Russion *read* Russian.

p. 146, line 18 from bottom: *for* Mjöberg *read* Mjöberg.

p. 154, line 20 from bottom: *for* flammande *read* damande.

p. 157, line 23: *for* London *read* Hereford, England.

p. 166, ninth and tenth entries: *supply accents, etc., as follows:* dessinée, française, itinéraires, Barnabé, opérations. Crimée.

p. 246, line 7 from bottom: *for* Dr. Frank D. Adams of McGill University *read* Mr. J. Adams.

p. 339, title of Fig. 1, line 1: *for* Geographical *read* Geological.

p. 407, line 28: Stupart, Frederic, *i.e.* Stupart, R. F.

p. 411, line 14 from bottom: *for* Sellard, E. S., *read* Sellards, E. H.

Additional Errata to Vol. II

p. 232, line 23 from bottom: *for* 1846 *read* 1821.

p. 387, line 7: *for* No. 9 *read* No. 15.

p. 471, line 15 of second item: *for* North Star Bay *read* Parker Snow Bay.

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